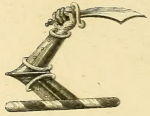

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Natural History.

ON THE

NATURAL HISTORY AND CLASSIFICATION

OF

FISHES, AMPHIBIANS, AND REPTILES.

BY

WILLIAM SWAINSON, A.C.G.

F.R.S. L.S. ETC.

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"THE EARTH IS FULL OF THY RICHES — SO IS THE GREAT AND WIDE SEA, WHEREIN ARE CREEPING THINGS INNUMERABLE, BOTH SMALL AND GREAT BEASTS.

— "THESE WAIT ALL UPON THEE, THAT THOU MAYEST GIVE THEM THEIR FOOD IN DUE SEASON."

PSALM CIV. 25. 27.

THE NATURAL HISTORY

OF

FISHES, AMPHIBIANS, & REPTILES,

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MONOCARDIAN ANIMALS.

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IN TWO VOLUMES.

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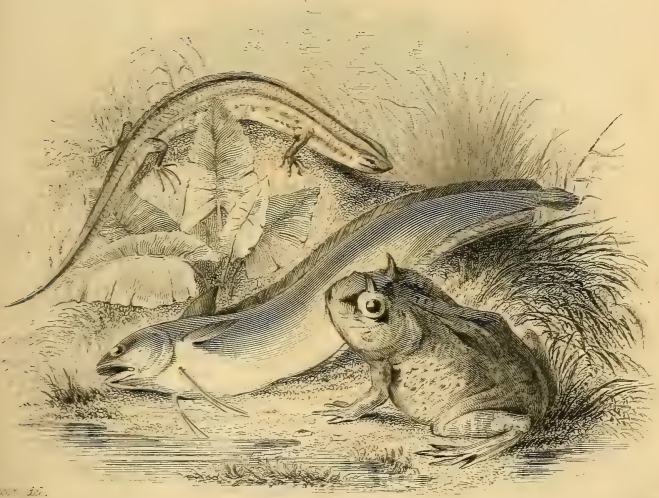

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ON THE

NATURAL HISTORY

AND

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OF

MONOCARDIAN ANIMALS.

PART I.

ON THE NATURE AND RELATIONS OF MONOCARDIAN ANIMALS: AND MORE ESPECIALLY OF FISHES.

CHAPTER I.

PRELIMINARY REMARKS. — ON THE GENERAL NATURE AND RELATIONS OF MONOCARDIAN ANIMALS.

(1.) We commenced our review of the animal kingdom with the proposition that it presented certain primary types of form, which, under a diversity of modifications, pervaded all the classes, and all the divisions, of this part of creation. The assertion was altogether novel, and somewhat startling, yet it was neither hastily nor presumptuously made. Many years had been devoted to those researches necessary to ascertain its general correctness, before we ventured to announce this theory, four years ago, in our "Preliminary Discourse." Ample time has thus been afforded for its refutation; but so far from this having been accomplished, it has not even been attempted. We may fairly conclude, therefore, that we are building upon no verv erroneous

foundation; we may presume, in short, that if the facts we have brought forward were capable of other inferences, and other combinations, those we have advanced would long ago have been overthrown; for mere individual opinion has nothing to do with the question at issue. We almost regret, indeed, that this has not been attempted by some naturalist with talents and knowledge equal to the task: such a discussion might have elicited many truths, and have led to many useful explanations. But the fact of the matter seems to be, that all those among our own countrymen whose works have placed them as the most eminent in the different branches of zoology they respectively cultivate,—all these, we say, with hardly a solitary exception*, have expressed their belief in one or other of the propositions formerly stated. That the old empiric mode of study is daily giving way to the inductive or philosophical, is a fact which will at once be placed beyond doubt, when we mention the names of MacLeay, Kirby, Horsfield, Westwood, Stevens, and Waterhouse, in entomology; Vigors, Sir William Jardine, Selby, and Gould, in ornithology; and John E. Gray, in general zoology. Now here we actually have the names of nearly all the most experienced naturalists and best known authors in the kingdom, who are thus, from their extensive knowledge of details, the *only* competent judges. Each of these have adopted, either wholly or partially, the theory of the circularity, the parallelism, or the symbolical relationship of natural groups. If the weight of authority, therefore, was to become the test of truth, the *Quinarians* may well exult in their strength. But this is not all,—the spirit has spread far and wide: we could name a long list of students, some indeed already masters, both in England and our colonies, who have caught the spirit of inductive zoology, and are now pursuing it with an ardour and a success that will soon render them worthy to fill the seats of those among us who may drop, full of years

* I believe I should bring into this list our admirable entomologist Mr. Curtis; but I know not exactly where his opinions have been expressed.

and of honour, into the silent grave. The day, in short, has gone by when mere opinions, unsupported by arguments, will have any effect among those whom they are intended to influence; or when new systems, built on an imperfect acquaintance with only one division of zoology, will be at all regarded by those who can alone give them notoriety; for higher naturalists have long dismissed the idea of studying nature under such narrow and purblind views. Our firm belief indeed is, that as these systems of late have emanated only from students, their very authors will throw them aside when greater experience shows how artificial and futile they really are.

(2.) In the two most perfectly organised classes of animals, quadrupeds and birds, we have endeavoured to show the prevalence of these primary forms, and the harmony that results from tracing their modifications. We are now to make a similar effort in respect to the remaining vertebrated classes. Our investigation, however, of the natural arrangement of these animals must be conducted, in part, on a different plan to that we have pursued in ornithology. We must occasionally adopt the *synthetical* rather than the *analytical* process of investigation; or, in other words, we must presume that our propositions, in the abstract, are correct, and that we have only to extend them to another class: we do this, not from choice, but from necessity. In the first place, the state of ichthyological science, to which the greater part of our two volumes will be devoted, however rapidly it has advanced in a knowledge of groups and species, is, and long must be, from the very nature of the animals upon which it treats, considerably behind ornithology. Inhabiting an element whose recesses cannot be explored by man, and with a peculiarity of structure and of colouring which renders their bodies very difficult to preserve, the natural history (properly so called) of fishes, when compared with that of terrestrial animals, will ever remain little more than a collection of a few superficial anecdotes; while, from the difficulty of their preservation and the unattractive

appearance they then exhibit, few will study, and still fewer will collect them. Hence the ichthyologist has much greater difficulties to contend with, in regard to materials, than he would experience in any other division of the *Vertebrata*, while he finds himself totally at a loss for that information on their natural habits, "their lives, and their loves," which gives such a charm to the history of other animals, and excites such a popular interest with the generality of readers. But to these difficulties lying in the way of nearly all who write upon ichthyology, must be added others, more particularly applicable to our present undertaking. So little has been done towards a *natural* classification of fishes, more especially, that to attempt those rigorous definitions we have ventured upon in the class of birds, would be altogether impossible. The synthetic mode of investigating our subject is, therefore, that which we shall in many instances adopt. We shall set out, it is true, with the impression that the same general laws which regulate the forms of quadrupeds and birds will be equally apparent in monocardian animals. But this belief is not to be received as true, upon trust; it is not to be unsupported by facts, or to remain as a mere assertion. We shall not, indeed, begin with analysing the smaller groups, and then gradually proceed to higher assemblages; for this is the analytical method of investigation—the very reverse of the synthetic: we shall, on the contrary, take a comprehensive view of those large assemblages, or groups, which nearly all our predecessors have agreed to keep distinct, however they may have differed in their subordinate details, or in the series wherein they have placed them. These we shall endeavour to define by their most prominent characteristics, and combine in such a way as that no palpable violation of nature should be committed. We shall then proceed to the results: it will then be seen how far this arrangement is in harmony with our previous disposition of the other *Vertebrata*, and how far it is supported by the analogies or resemblances that may be traced between them and the

primary types, which we set out with supposing to exist.

(3.) Our introductory notices will contain, as formerly, a rapid sketch of the chief peculiarities of these classes, more especially in regard to their external anatomy; not only as being that part of their structure most essential for determining the species, genera, and families, but also because it can be best understood and comprehended by all. Our own classification, in fact, is as strictly founded on anatomical organisation — even more so — than those of any of our predecessors; with this difference only—that we have selected the more determinate characters for the definition of our groups, rather than resting them solely upon one or two. It is a law of nature, that the internal and external anatomy are mutual indexes to each other; and, therefore, to give a preference to internal characters (manifested only to the view by skilful dissection) over such as are apparent externally, has ever appeared to us not only objectionable, but absolutely unnecessary. The study of zoology, from its vast increasing extent and consequent difficulty, stands in need of every help and of every facility for its acquirement. Comparative anatomy, indeed, is of the highest importance in determining questions which could otherwise not be solved; but among vertebrated animals, at least, this study seems to have been pushed much too far; and if ichthyological groups are to be regulated by the bones of the head and the armature of the mouth, we may, with equal propriety, draw up an ornithological system from the structure of the windpipe, the form of the sternum, or the number of the vertebræ.* Were it possible to frame such systems — which it manifestly is not—very many facts, of peculiar interest to the mere comparative anatomist, would unquestionably result. But the question arises, of what practical use would they become? The great mass of mankind look

* Since this was written, a system, much on this plan, has actually been but forth in one of our periodicals: the next month will probably bring out another, founded on the structure of the gizzard, or the bones of the cranium, to add to the ninety and nine that have already died natural deaths.

to scientific men for placing the different branches of human knowledge before them in the most easy and comprehensible form consistent with sound philosophy; and however highly they may estimate the profundity of those who expatiate on the intricacies of their art, they will most assuredly follow and admire such writers only as choose an opposite course; and by the simplicity of their instruction, and the facility with which their researches may be verified, hold out attractions to those who desire to see science disencumbered of all unnecessary mystery, abstruse technicalities, or empirical assertions.

(4.) In prosecuting our labours upon these principles, we shall, in the first place, inquire into the station occupied by the monocardian animals in the zoological circle; and then, taking each of the classes of fish, amphibia, and reptiles, separately, condense the most remarkable and essential facts relative to their organic structure, both internal and external. Of these three classes, ICHTHYOLOGY, or that which treats of fishes, will claim our first and chief attention, not only as being by far the most numerous and interesting, but also because it is that with which we are most conversant. Ichthyology, in fact, engaged our attention long before ornithology; and no opportunity has been lost, during a period of twenty-three years, of making drawings and descriptions from living specimens in all those foreign countries we have visited. Many years' residence in Sicily and other parts of the Mediterranean will enable us to give much information, hitherto unpublished, on the rarer fishes of those coasts, sufficient, at least, to show how imperfectly they have as yet been made known. Our information on the reptiles and *Amphibia* is more confined; but as the determination of the natural groups, and not the species, is our chief object, this circumstance becomes of less consequence. In this we have derived much assistance from the labours of our friends MM. Gray and Bell, as well as from the numerous and valuable continental works published of late years on these animals.

(5.) FISHES, along with frogs and reptiles, constitute

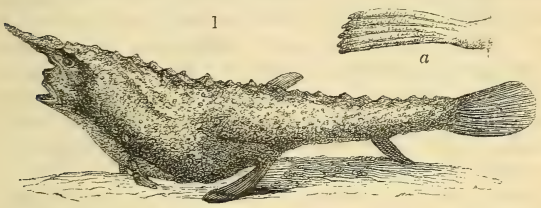
that great and primary division of vertebrated animals which are distinguished by their *cold* blood, in opposition to the two classes of quadrupeds and birds, which have their blood *warm*. In all cold-blooded *Vertebrata*, the body is either naked—that is, merely covered by a skin more or less thick—or it is protected by osseous pieces or plates: in some, these plates are excessively hard, and are joined together at their edges, as in tortoises, and in some few of the aberrant fishes; but in the majority, both of the fishes and reptiles, the plates assume that form denominated *scales*, the outer edge of one reposing upon the base of the next.

(6.) The rank of the monocardian classes in the circle of the *Vertebrata* has already been touched upon.* All naturalists, both ancient and modern, agree in considering them—what, indeed, is self-evident—as the most imperfect or least organised of vertebrated animals; from the types of which, as seen in quadrupeds and birds, they are at once distinguished by their cold blood,—a character which is perfectly absolute, inasmuch as no exception has been yet discovered: for no quadruped or bird, now in existence, has any other than warm blood. M. de Blainville, we believe, was the first naturalist who absolutely arranged the *Amphibia*, or frogs, as a distinct class from the true reptiles. And although this improvement on the old method has not been adopted in the *Règne Animal*, it has generally been followed by subsequent naturalists. Indeed, the very circumstance of the amphibians, as Cuvier himself says, passing from the form of a fish respiring with gills, to that of a reptile respiring by lungs, is quite sufficient to separate them both from fish and serpents; since this very structure points them out as forming a link by which the two are connected. The scientific world, however, have long made up their minds on this question; and we thus find the aberrant division of the vertebrated animals resolvable into three others, namely, 1. *Pisces*, or fishes; 2. *Amphibia*, or frogs; and, 3. *Reptilia*, or serpents.

* Classif. of Quadrupeds, p. 45. Classif. of Animals, p 204.

(7.) The relations which these animals bear to quadrupeds and birds may next be glanced at. Commencing with fish, we find that the dolphins, porpoises, and the other aquatic *Mammalia* without feet, were always regarded by the ancients as true fishes; and even Artedi, the great renovator of ichthyology in the eighteenth century, viewed them in this light. The passage, therefore, from quadrupeds to fish is absolutely perfect; and the affinity of the sharks to the dolphins shows that this passage takes place among the cartilaginous fishes; of which Cuvier remarks, that they also evince an affinity to the *Reptilia*. Fishes are remarkable, among their other peculiarities, for being destitute of feet; these members being replaced or represented by two sets of fins; the pectorals representing the anterior feet of four-footed beasts, while the ventral fins equally represent the hinder feet. But among the least perfect or aberrant groups of this class we find these fins so constructed, that they are placed on a jointed peduncle, so that they have nearly as strong a resemblance to the foot of a frog, or that of a swimming bird, as to a fin (*fig.* 1. *a*); nor is this in appearance only; for it has been frequently asserted by those who have seen the Indian *Chironectes*, or frog-fishes, alive, that those singular animals crawl about by means of these foot-fins, and that they are so far amphibious as to live comfortably two or three days out of water. Their thick grotesque shape, naked and tuberculated body, and their whole general aspect, give them, in short, much more the appearance of frogs than of fishes, — an assertion to which the most unscientific of our readers will acquiesce upon looking to the annexed cut of the *Malthe nasuta* Cuv. (*fig.* 1.), accurately drawn from a specimen we procured on the Brazilian coasts: (*a* is the pectoral fin.) Nor is this a solitary affinity between the amphibians and the fishes; the whole of Cuvier's genus *Chironectes*, which is evidently a natural family, abounds with similarly formed animals, where the general aspect and characters of true fishes are so much changed as to assume the appearance of frogs. Quitting

the fishes by these compound animals, we enter among the batrachians, or *Amphibia;* composed of the frogs, toads, sirens, salamanders, efts, and a few other lizard-formed



animals, distinguished from all other *Vertebrata* by the heart having but one auricle, the body naked, and the whole animal undergoing metamorphosis before it reaches maturity. All these are furnished with either two or four feet; but sometimes these members are so small, that they appear more as rudimentary appendages; while, in their eel-shaped bodies, they so much resemble many of the apodal fishes, that it may hereafter become a question whether the true passage between the classes is not effected by the eels in one, and the sirens in the other. So closely do the salamanders, again, resemble the lizards, that none but professed naturalists can tell their difference; so that the classes *Amphibia* and *Reptilia* are thus inseparably linked. The connection of the saurian reptiles, or lizards, to the ophidians, or serpents, need not here be insisted upon. The passage from these latter to the gigantic *Ichthyosauri* is again rendered easy by the *Plesiosaurus*, where the head and neck of a serpent seems engrafted, as it were, on the body of an *Ichthyosaurus*. Lastly, it is quite evident that the flying lizards, or *Pterodactyli*, belong to the same great group, and to the same era as the aquatic monsters of a former world just mentioned; and it is equally certain, that of all the reptiles yet discovered, these make the nearest approach to birds: the fore-feet, in fact, were dilated into wings, like those of a

bat, while the hinder ones were clearly intended for walking: the jaws are enormously prolonged, analogous in their length to those of a woodcock: the whole structure, in short, is such an extraordinary compound of a reptile and a bird, that no doubt can remain on the affinity between the two classes; for although the passage is not marked by existing animals so clearly as that between quadrupeds and fishes, it is quite evident that the *Pterodactyli* are more allied to birds than to any other vertebrated animals out of the class of reptiles.

(8.) By thus tracing the natural series of the vertebrated animals according to their affinities, we find they form one great circle. Commencing with quadrupeds, we pass on to fishes; to these succeed the amphibians and the reptiles: these latter are followed by birds; and birds, as already explained, bring us back again, by a different route, to quadrupeds.

(9.) We are now to investigate, however, the truth of another proposition formerly stated regarding natural groups; which was, that the aberrant divisions of every circle formed a distinct circle by themselves, quite independent of their union with the two typical circles. Now, the aberrant divisions of the *Vertebrata* are the fishes, amphibians, and reptiles. Two questions therefore arise: first, Is there not a greater similarity between these three, than there is between them and quadrupeds and birds? and secondly, Is this similarity so strong as to favour the belief that they actually do unite into a circle of their own? The first question must, of course, be answered in the affirmative; for although an ordinary observer might easily mistake an eel for a serpent, a salamander for a lizard, a young frog for a fish, or even a *Chironectes* for a frog, no one is likely to confound any one of these animals with a quadruped or a bird. As to the second question, we have the opinion of Cuvier,—an opinion adopted by others, that many of the cartilaginous fishes evince a decided affinity to the reptiles; and this is the very point where the two extremes of the monocardian animals would meet, if

they really formed a circular group by themselves. Again, it is notorious that some of the eels of the genera *Muræna, Ophisurus,* &c. have so completely the aspect of the water serpents, that it is only upon the naturalist examining them, that their different classes are detected.* Upon the whole, therefore, we must admit that every thing yet known regarding the classes in question strengthens this belief, and adds another instance to what we have seen among birds, that the "primary divisions of every group are *three* actually, but *five* apparently."

CHAP. II.

ON FISHES IN GENERAL.

(10.) FISHES constitute by far the most numerous class of vertebrated animals, whether we regard the number of individuals, or the variety of their forms. When we consider that more than two thirds of the globe is covered by water,—that element peculiarly appropriated for their habitation,—we shall not be surprised at this superiority of numbers. On the contrary, we may fairly suppose that not more than one half of the species really existing have yet been made known.

(11.) The peculiarities in the inward form of fishes, by which they are distinguished from all other animals, need not be enlarged upon; yet, as many of them, like the eels, assume the form of serpents, and others resemble the young of the amphibian frogs, it is necessary to characterise them as *aquatic vertebrated animals, breathing by means of internal gills,* and undergoing

* The museum of the Zoological Society contains many striking illustrations of this fact.

no metamorphosis. These gills, or branchia, as every one knows, are composed of certain semicircular arches, fringed, as it were, with thin fleshy processes, resembling little leaves, or laminæ, having innumerable blood-vessels: the water taken in by the mouth, again escapes between the openings of the branchia, which are protected externally by certain bony plates united together, yet generally movable, which are called the *operculæ*, or gill covers: this apparatus for breathing is variously modified, but never lost, so that it is the primary character by which fishes are at once distinguished from reptiles and amphibians.

(12.) The *operculum*, or gill cover, just mentioned, is articulated on the *os tympani*, and is moved upon a piece called the pre-operculum: it is composed of three bony plates, termed the *operculum*, the *sub-operculum*, and the *inter-operculum;* the modifications of which are sometimes of much use in determining natural affinities. In many groups, however (as in the eels), the operculum is so entirely covered by the common skin as not to be visible but upon dissection; and among the cartilaginous and some other fishes, the operculum is entirely wanting.

(13.) The SKELETON of all fishes, except such as are lowest in the series, present a vertebrated column, and other internal bones; but the structure of these bones is very different, and, as may be expected, indicate the primary divisions of the whole class. In the most perfectly formed fishes, the bones are completely osseous, and generally of great hardness: in another large division, they are fibro-cartilaginous — that is to say, the base or heart of the bones is of gristle, or is cartilaginous, mixed only with fibres or layers of phosphate of lime, so that the texture is never so hard as in the osseous groups just mentioned: some of these semi-cartilaginous genera, indeed, have their bones quite soft, and thus lead to the third group, or truly cartilaginous fishes, which, like the sharks and skates, have their skeleton composed of gristle or cartilage

only. In no fishes, however, is there any medullary canal. The more perfect groups or orders have ribs, but these disappear in many of the fibro-cartilaginous genera; and finally, in such as pass into the annulose animals or insects, the whole skeleton is soft and membranaceous: first the fins, then the eyes, and, finally, the vertebrated column itself, almost disappear, so that we have the mere external form of a worm, provided with a mouth.

(14.) As fish are destined to inhabit an element where motion is much more essential to them than either to quadrupeds or birds, their Omnipotent Creator has given them greater powers for sustaining this motion than are possessed by any other animals in creation. Their body, in fact, is surrounded by fins; and their tail (the fin of which acts as a rudder) is generally as thick, and often much longer than the body itself. These are the only members adapted for motion possessed by fishes; but their construction, number, and position, are varied in almost an infinity of ways, and thus contribute some of the most obvious and natural characters for determining the different families and genera. As the formation of the fins comes under the head of external anatomy, we shall subsequently treat of these members more at large.

(15.) The AIR-BLADDER is situated immediately under the spine: by being compressed or dilated, it influences the specific gravity of the fish, and assists it in rising or descending in the water. This vessel, however, is very partially possessed; and even its presence or absence may be detected in genera, and even species, which are closely and internally allied, so that it becomes of no value whatever as a character for designating groups.

(16.) The MOUTH is sometimes provided with very strong teeth, and sometimes entirely without; and this remarkable variation takes place in genera close to each other, and even, according to some of Cuvier's groups. in species of the same sub-genus. The anatomical

structure of the mouth may be thus described: — The inter-maxillary bone, in most fishes, forms the edge of the upper jaw, behind which is the *os labiale*, or maxillary; a palatine arch, composed of the palatine, the two pterygonian processes, a jugal bone, a tympanic and squamose bone, constitutes, as in birds and reptiles, a sort of interior jaw, and supplies, behind, an articulation to the lower jaw, which has, in general, two bones on each side. In such fish as have teeth, these processes are varied in innumerable ways: they are found, for instance, on the inter-maxillaries, the maxillaries, the lower jaw, the vomer, the palatines, the tongue, the arches of the gills, and even on certain bones, behind the latter, called by Cuvier *ossa pharyngis*.

(17.) A few other anatomical characters may be briefly noticed. The nostrils are situated between the eye and the end of the muzzle or upper jaw, and are usually double, that is, opening by two perforations on each side. The eyes are usually rather large for the size of the body; but in some types they become very small, in which case they are always situated on the top of the head, and are then termed vertical; the cornea is very flat, the aqueous humour small in quantity, while the crystalline is nearly globular, and very hard. The tongue is small, hard, and bony; so that the taste enjoyed by fishes, must be very trifling.* The stomach and intestines present nothing essentially peculiar: in the generality of fishes, the *pancreas* is represented either by *cæca* of a peculiar tissue, situate round the *pyloris*, or by this tissue itself, at the commencement of the intestines: the kidneys are placed on the sides of the spine; but the bladder, contrary to what is seen in quadrupeds, opens behind the anal and the generative organs. The majority of fishes are oviparous; but the cartilaginous order, and a few others representing them,

* This sense, indeed, is rendered almost unnecessary, for the great majority of fishes swallow their food whole. This is one of the great characteristics of the fissirostral type of birds; and as the fishes represent the same type in the circle of the *Vertebrata*, we are accordingly prepared to expect such coincidence.

are viviparous, the young being protruded through a very short canal.

(18.) On the external anatomy of fishes, and of their natural history, we shall be less concise. Next to the structure of the bones, the *fins* claim our greatest attention; since it is an acknowledged fact, that the organs of locomotion are those which have furnished the best characters, above all others, for distinguishing the various subdivisions, not only of vertebrated, but of annulose animals. We shall first describe their number and position, and then point out several interesting conclusions resulting therefrom.

(19.) There are FIVE sorts of FINS possessed by the typical groups; which are named pectoral, ventral, anal, dorsal, and caudal: the two first of these are in pairs, and are the most important, inasmuch as they represent those members in the higher organised *Vertebrata*, that are called legs and wings. The pectoral fins, in fact, are only the anterior feet of quadrupeds, and the wings of birds, presented under a new and strikingly different form: the three other fins are single, or, in other words, they are not in symmetrical pairs. Each of these will require a separate consideration, more especially as they have hitherto been regarded with little attention.

(20.) The *pectorals* are, obviously, the most important to fishes in general; because we find them in groups, where several of the other fins are wanting, and it is only among the lampreys, and a very few genera, so low in the scale as to form a passage to the worms, that they disappear. In the majority of fishes they are of the same moderate size as the ventrals, but in particular families they become much more developed: they are always composed of flexible*, and, generally, branched rays, so as to yield to every stroke on the water made by fishes in the act of swimming. When the shape is pointed or triangular, the first ray is either very strong or spinous. This spine, in the silure family, is not only remarkably

* The only exception we are aware of at this moment, is a small species of blenny, the *B. variabilis* of Rafinesque, whose pectoral rays are all spinous.

thick, but is generally barbed on one or both sides, so that it becomes a formidable weapon of defence. The great importance of the pectoral fin to the rapid motion of fishes is still further manifested by the fact that, in all such groups as are peculiarly rapid, the pectoral fin is pointed, or rather triangular. The flying fish, the tunny family, the rays, are familiar examples of this form in its highest state of development; while we find the same, in a less degree, among the *Spari*, the herrings (*Clupeidæ*), the typical cod-fish, *Gadiadæ*, and many others. These, in fact, are nearly all pelagic fishes, performing, like fissirostral birds, either annual migrations, or living almost entirely in the open sea except at the breeding season. In such families, on the contrary, as live in rivers and lakes, or only in shallow rocky shores, the pectoral fins are always round. The whole of the apodal or anguilliform order, in which are the eels, the lampreys, and the suckers, together with the blennies, gobies, the rocklings (*Motella*), and numerous other families, are of this description. Even the *Triglidæ*, or gurnards, and their allies, although their pectorals are of an extraordinary size, yet, with the exception of those of the fissirostral types, they are always round; and it is well known that these fishes keep near to the shore, and live near the ground. There are some singular modifications of the rounded pectoral, which deserve particular notice; for they are either, 1. partially cleft; 2. digitated; or, 3. very broad at their base, and extended under the throat. Examples of the first are seen in the genera *Lepidopus* and *Cheilodactylus*, and in a very few others, where the middle rays are shortest, so that the fin appears lobed in the middle; but in the last named genus, some of the lower rays, or those nearest the belly, are much longer than the others: the fin has thus an appearance of being injured. The pectoral of *Cephalocanthus* is represented (Cuv. pl. 73. 77.)* as being rounded, but divided in the middle, without any diminution in the length of the rays. In

* I have not had an opportunity of examining this rare fish.

Cirrhites, again, the last five rays are not only spinous, but much thickened and prolonged beyond the membrane; a structure which excites a strong suspicion of this genus being analagous, in its own circle, to *Cheilodactylus*; and this seems the intermediate state of development leading to the next. 2. Digitated pectorals are exclusively confined to the typical *Canthileptes*, or gernards, and spine cheeks (*Scorpænidæ*). Among the first, and particularly in the genus *Trigla*, there are three detached, finger-like processes, unconnected by any external membrane, which are situated just before the lower base of the pectorals, and which almost appear to be detached rays of this fin, much thickened, and somewhat removed from the connected rays. In the Mediterranean and Atlantic *Dactylopteri*, these extraneous rays are united by a membrane, so as to form a spurious or supplementary pectoral; while in those from India, of which there now appears to be several species*, this supplementary fin is united to the true pectoral so as to form but one. The pectorals of nearly all the remaining families of this tribe have the lower rays, or those nearest the throat, thickened; much in the same way as in *Cirrhites*, but with this difference, that the fins are so broad at their base, on account of the number of rays, that they are often carried half-way under the throat; a character so very peculiar, that we look upon it as a distinct modification. It seems probable that this unusual strength is given to such fish as have very large heads, for the purpose of additional support; for it will be observed that the heads of all these genera are not only large, but particularly heavy, on account of the bony armature with which this part is covered; and it may be further remarked, that it is among small headed fishes we find the most delicate pectorals. In truth, however, nothing can be affirmed with any degree of confidence on the reasons of these variations from the ordinary structure. We cannot, as in land animals, watch the habits and explore the

* See the Appendix, wherein these are described.

haunts of these marine creatures: the most we can do, is to found our conjectures, on such matters, upon analogical reasoning.

(21.) The pectoral fins, as being the wings of fishes, are consequently found in the highest state of development in such families as represent the fissirostral and natatorial birds, whose powers of flight are so superior to others. Hence we find that in the two chief families of the cartilaginous order, namely, the sharks and rays, these fins are universally very large, and in the latter they are so much developed as to occupy more than one half the surface of the body; they appear, in fact, to be surrounded and enveloped in their enormous pectorals, which, being generally angulated or pointed, must give to these rapacious monsters a swiftness of swimming analogous to that possessed by their representatives, the swallows, in flying. The pectorals of the sharks, although not proportionably large, still exceed all the other fins in size; and thus render them such rapid swimmers. The actual volatile powers of the flying-fish is, likewise, entirely owing to the enormous size of their pectorals; but there is nothing peculiar in their shape or construction, since they merely have the form and structure of an ordinary pointed fin, only excessively enlarged. Now, as we find these fins are very complete in fishes which are constantly moving about in their watery element, as birds do in the air, so, among such as are more stationary, and swim but little, the pectorals are proportionably small: this is particularly observable in the family of the *Pleuronectidæ*, or flat fish, whose whole structure is adapted for laying flat upon the bottom of the sea, and there waiting for their prey in ambuscade. These fishes, in proportion to their size, have the smallest pectorals in the whole class; while the flying fish, which habitually live only in the wide ocean, and are perpetually traversing it, have the largest. The *Lophidæ*, or fish-frogs, again, may almost be said to have no real pectoral fins, inasmuch as these members are so formed as to perform the office of feet,

with which they doubtless crawl on the bottom of the sea, just as they are known to do when placed upon land. The pectorals of the *Malthe nasuta*, as before remarked (*fig.* 1. *a*), are rather paddles, or cartilaginous lobes, than real fins; the rays are numerous, but so close together, and the membrane which connects them so tough and inextensible, that we feel fully persuaded they are more used for walking than for swimming.

(22.) Having just mentioned the processes of the pectoral fins in the *Triglidæ*, we may here notice those of the genus *Polynemus*, which are strikingly analogous to, although very different in structure from, the digitated processes of the former. The general form of these fishes bears much resemblance to the grey mullet, while their serrated gill-covers show a relation to the percoid families; from both of these, however, they are too distinct to be classed as a subordinate group; while the fact of these and the *Triglidæ* being the only genera possessing pectoral processes, has induced us to class them as the representatives of each other. In *Polynemus*, these processes assume the form of slender, setaceous, and articulated rays, varying in different species from four to ten on each side, where they are inserted a little in advance of the pectoral, and are sometimes so long, as in *P. paradiseus*, as to exceed the entire length of the whole fish. Although this and several other species are by no means uncommon in India, the use of these processes remains to this day entirely unknown.

(23.) The VENTRAL fins rank next to the pectoral, as representing the hinder feet of four-footed animals, and the legs of birds. That they are less necessary, however, to the swimming motion of fishes, than either the dorsal or caudal, may be presumed from the fact, that in the entire order of *Apodes*, or eels, these fins are totally wanting: they are the smallest in size of all the others, but by no means always so. In general they are less than the pectorals, often of the same size, and very rarely, as in *Gymnetrus* and *Zeus*, considerably larger. Much diversity is observable in their situation and form: like the pectorals,

the rays are always soft; but those in the spine-rayed fishes are strengthened by an external spine, which of course is never branched. Linnæus employed the situation of the ventral fins to construct some of his primary divisions; classing together those which had the ventral placed before the pectoral, those in which it was immediately beneath, and those where it was placed behind. This plan did very well in the infancy of our science; but it was soon discovered that this artificial arrangement separated the most natural and connected genera into different orders, and that even, if rigorously acted upon, individual species would be similarly dissevered. M. Cuvier has therefore, with much propriety, rejected these divisions, and yet not so thoroughly but that some of his great groups are formed nearly on the very same artificial principles as those of Linnæus.* The situation of these fins, however, is by no means unimportant, when used for subordinate characters: in some, as in *Pteracles* and *Uranoscopus*, they are placed immediately under the throat; in others, as the sharks, they are nearly half way between the pectoral and the caudal; while in that extraordinary genus, *Polypterus*, it is close upon the base of the caudal fin.

(24.) The *shape* is no less diversified: in the great majority of fishes it is symmetrical with the pectoral fin; both being either round, as in the *Labrinæ*, or pointed, as in the *Sparinæ*. Several instances occur, however, where this uniformity is disturbed: in some of the *Chætodonidæ*, the pectorals are obsoletely rounded (as in *Platax teira* Cuv.), but the ventrals are particularly long and pointed; while in *Taurichthys varius* (if the figures of these two singular fishes are correct) the pectorals are acutely pointed, while the ventrals are decidedly rounded. We cannot but entertain some suspicions, however, on the correctness of these figures; and, indeed, the difficulty of making accurate drawings from preserved fish, whether dried or in spirits, is frequently so great, that

* Such, for instance, as the divisions of the order *Malacopteryges*, and the insertion of *Trachinus* and *Uranoscopus* among the perches, because they have jugular ventrals.

some allowance must always be made on this head, even to the best artists. The more unusual forms of the ventral fin may now be noticed. Sometimes it is single, and merely represented by a prickle, as in *Psettus Sebii*, and a large number of the cheloniform fishes (*Balistes* Linn.); more rarely there are two spines, representing the two anal fins; for although, strictly speaking, the bony processes in the cheloniform fishes are not real ventrals, yet, as they perform the same office, and are placed in the same situation, we see no reason why they should not be so termed. In the type of the genus *Xiphias*, or sword-fish, the ventrals are entirely wanting; but in the sub-genus *Histiophorus* they consist of two slender cirriform filaments, either of equal lengths, as in *H. indicus*, or with one shorter than the other, as in *H. pulchellus*. The majority of the *Gadiadæ*, or cods, and of the *Blennidæ*, or blennies, show us an equally slender form of ventrals; sometimes with a single worm-like ray, forked towards the middle, as in the hakes (*Physis* Cuv.); and sometimes with three, four, or five other rays: yet these latter are generally so diminutive, that they become merely rudimentary. Five soft branched rays, and one spined or stronger one in front of the others, is the usual number seen in the ventrals of ordinary fishes. The most remarkable modification in the form of this fin is seen in the sucking or adhesive fishes, of which there are two distinct groups, both possessing the power of adhering, by this member, to other substances, but very different, not only in their general organisation, but in the structure of those members by which this property is performed. One of these is the family of gobies, *Gobiadæ*; the other, that of the *Cyclopterinæ*, or true suckers: in the first, the two ventral fins are united, so as to form a circular funnel. Upon what occasions, however, this instrument of adhesion in the gobies is used, remains at present unknown. Montagu has observed, that in live gobies which he has captured, and put into vessels of water, no instance occurred

of the fish adhering to the sides, or to the hand. This perfectly accords with the result of our own observations upon a great number procured on the coasts of Sicily, where this genus abounds. Nevertheless there can be no doubt of these fins being formed for suction; and the probability seems to be that they are only used in stormy weather, when the water is violently agitated. After such commotions of the sea, we have frequently picked up on the beach many small fishes seldom seen on other occasions; but, although the gobies are nearly all very small, and often delicate, we never remember to have found a single specimen cast up upon the beach. The true suckers, however, forming the genus *Cyclopterus*, possess the faculty of adhesion in an extraordinary degree. On the breast and belly are two circular concave disks: one of these is formed by the extension of the pectoral fins under the breast; the other by the union of the ventral fins. The tenacity with which these fishes adhere, upon being captured, to the first object which comes in their way, is very remarkable. Their form is repulsive; and they fasten themselves so firmly upon the hand, that, to inexperienced persons, an involuntary feeling of dread arises in the mind, lest they should be venomous. If loosened from the hand and placed in a vessel of water, they immediately swim with a quick undulating motion, and affix themselves to the sides. Several species of these fish occur on the British coast; and others, quite different, are not uncommon in the Mediterranean. The most extraordinary ventral fins are seen in some of the *Gymnetes*, or riband-fish, where the rays sometimes resemble oars, being spatulate or broad at the tip. This form is peculiar to the genus *Gymnetrus;* but in that of *Trachypterus* (Gouan) the rays are even still longer, and appear to consist of slender flexible filaments.

(25.) The DORSAL fin, with the anal and caudal, are the three members for progression, of which nothing analogous can be traced among quadrupeds and birds;

except, indeed, that the caudal fin represents the tail feathers of the latter, but not the true tail of the former, which is an actual continuation of the vertebræ. The dorsal, after the pectoral, seems to be the most essential for the aquatic economy of fishes, because there are only a very few instances yet known where it is entirely wanting, and all these occur in that order where the fins gradually disappear, and nature passes into the marine worms. There seems to have been a notion that the office of the dorsal was to preserve the fish in a perpendicular position; but some recent experiments does not sanction this idea, and there is every reason to suppose that this object is really effected by the pectorals, which, being placed symmetrically, one on each side, preserve the body in equilibrium. Besides, it is quite clear, that if this purpose could only be effected by the dorsal, it would follow that such fish as the *Gymnotus brachiurus* and its allies, where this fin is altogether wanting, could not swim at all. Yet these are compressed fishes, and, therefore, obviously intended for a perpendicular position; and they all have pectorals. Dorsal fins will now be viewed as regards their construction, number, form, and disposition.

(26.) The *construction* of the dorsal is so far like the other fins we have been describing, that it is generally composed of rays, connected, either partially or entirely, by a membrane: but then the nature of these rays varies in the different groups; and in certain families, where there are two dorsal fins, the hinder one is adipose, that is, resembling a thick fleshy lobe, attached to the back, and covered by the common skin, in which neither rays nor membrane can be distinguished. Fins of this description, with but one exception yet discovered, are confined to the soft-rayed fishes. Native examples occur in the salmon family: while among the *Siluridæ*, or cat-fish, these fins are almost universal. The *Gadiadæ*, or cods, show us the next advance towards a more organised construction: the fins, indeed, are

composed of rays; but these rays are so very slender, and are so thickly covered by fat and skin, that in many instances they cannot be counted without dissection: the whole of the *Gadiadæ*, in fact, have their dorsals remarkably thick and fleshy, so that the rays by which they are supported only become distinct towards their termination. It is in this family, also, that we find a modification of this fin unexampled among fishes. In the rocklings, forming the sub-genus *Motella*, there is, before the true dorsal, another, which may be termed a rudimentary fin: it is composed of a great number of extremely fine, short, fleshy filaments, resembling cirri, preceded by one somewhat longer and thicker than the rest, but all united at their base by a true membrane: the peculiarity consists in these filaments having the form of rays, without the least degree of firmness; for in other respects these fins are formed in the usual manner, and are situated in a deep groove.

(27.) The *spurious fins*, or finlets, as they are sometimes called, seen in mackerel and other allied genera (*fig.* 2. *d*), may be considered as a modification of the true adipose dorsals in the corresponding or analogous group of the salmons, among the soft-rayed families. They may be considered as single detached rays, excessively branched from their insertion on the back, where they are remarkably thick and fleshy: like the adipose fins before described, ythe are always situated behind the first dorsal; but while no fish has yet been discovered with more than one adipose fin, those which we are now speaking of are almost always numerous, varying, among the mackerel, from four to seven, and even more. The only two genera yet known, we believe, where these finlets are placed near to the head, are those of *Polypterus* and *Plesiops*: in both these, indeed, they supply the place of the true dorsal fin, the remnant of which, so to speak, only shows itself in a few connected rays, adjoining and uniting with the caudal.

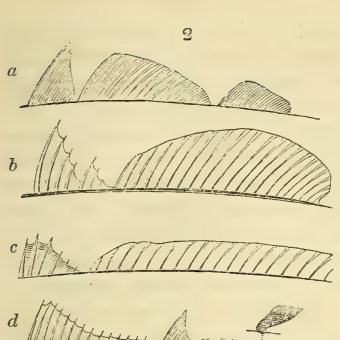
(28.) The dorsals, as well as all the other fins, among the cartilaginous fishes, are so thick, from being covered

with the common skin of the body, that their rays are completely hid, except in such few as are provided with an anterior spine, which, being obviously employed as an offensive weapon, is consequently naked, and partially unattached to the other rays. The fins of the *Pleuronectidæ*, or flat fish, are nearly as thick as those of the cods; but the rays, being spinous, are more naked at their extremities. Those lovely fish, the chætodons, have their dorsal fins remarkably thick, and so covered with compact scales, nearly to their margins, that their motion would seem to be very limited. The great majority of thick-finned fishes are found in the soft-rayed order (*Malacopteryges*), while those of an opposite nature are almost confined to the typical osseous division, or the *Acanthopteryges*. The dorsal fins of the great tribe of perches, together with those of the *Spari*, *Labri*, *Triglidæ*, *Gymnetes*, &c., are thin; that is to say, the rays, whether slender or strong, are not in any way covered by the common skin of the body, but are bare almost to their base, and united by a thin membrane, sometimes, indeed, beautifully coloured and opaque, as in *Serranus*, *Perca*, *Labrus*, &c., but generally sub-transparent, and almost colourless, as in the whole of the *Sparidæ*, *Scomberidæ*, *Zeidæ*, &c.

(29.) The *number* of the dorsal fins is variable; for although they are all placed upon the same line, which is invariably the ridge or summit of the back, they are yet separated, more or less, into divisions; and these, when perfectly detached one from the other, are viewed in the light of separate fins, although, strictly speaking, they should simply be considered as so many divisions of a single one. Where the intervals are marked by a secession of a connecting membrane between the rays, there is no difficulty in determining whether, according to the common mode of reckoning, a fish has two or three dorsal fins: but it frequently happens, even in the same genus, that in one species the membrane of the last ray of the first dorsal terminates or adheres to the back; while, perhaps, in the very next it

is attached to the base of the anterior ray of the second dorsal; so that, in effect, although there are two divisions, or fins, yet they are, in fact, connected, and, consequently, become one. The genus *Gadus*, as now restricted, has obviously three dorsal fins, each separated by an interval from each other (*fig.* 2. *a*); while in the genus *Blepsias* there are also three (*b*), nearly of the same form; and yet, because they are very slightly united by a membrane, in the manner above described, this genus is said to have but one dorsal. Now the transition from two approximating dorsal fins to one, cleft between the spiny and branched rays, is so gradual, that it is impossible to define every stage of the progression; and much ambiguity will always attend this part of the definition of the subordinate groups. Nevertheless, as characters taken from the fins will be eventually found to be of much more real and practical value than has hitherto been supposed, we should propose the adoption of the following terms, as calculated, in some degree, to express the modifications just mentioned. Where, for instance, a portion, however small, of the naked back intervenes between one or more of these divisions, as in the common cod (*a*), they may be considered, as at present, three distinct fins. When the last membrane of the first dorsal is in any way united to the anterior ray of the second dorsal, we might consider them as "two dorsal fins united;" and when this union is so close, as that the membrane in question *ascends* up the side of the next ray, instead of descending in a direction to the base, we would then term the dorsal fin "single, but emarginate," deeply, or slightly, as the case may be. The annexed cuts will more effectually explain our meaning; and we may now consider their other peculiarities.

(30.) The *rays* of the dorsal are either simple or branched. Simple rays, again, are of two sorts: sometimes they are slender and flexible, although without any joints; in which case they are generally terminated by a fleshy or membranaceous filament; and



these are either isolated, as in *Dactylopterus*, or united to the dorsal fin, as in most fishes. The general character, however, of simple rays is that of being strong, rigid, and so sharp as to become spinous: that these spines are used as instruments of defence, becomes evident from the fact of many fishes suddenly raising them when captured, so as to inflict wounds on the hand of an incautious person; and that they also are essential to the perfect use and efficiency of the fin itself, by strengthening and supporting the other rays, is also to be inferred from this fact,—that in all soft-rayed fishes the first ray of the dorsal, if not simple, as in the carps, &c., is almost invariably stronger than the others,—a structure intended to break the resistance of the water during the swimming of the fish, on the very same principle that a boat or vessel is furnished with a stem. Fishes which swim but little, and in calm waters, like the eels and a few others, do not possess this peculiarity; but in those which belong to the most perfect division of the osseous fishes (the order *Acanthopteryges*), the development of the spiny rays is at its maximum, and constitute the primary distinction, even by the confession of Cuvier, of this most natural group. Sometimes these spines are detached and isolated, when they are always short, and repose in a groove on the back (as in *Naucrates*, &c.); in which case, however efficacious they may be for defence, they can be of no use in swimming. When these spines

are so very short as just to appear above the scales, they have no membrane; but if longer, a slight one connects each of them to the back, but not to each other: in general the point is directed backwards; but in some few genera, allied to the mackerel, some of these prickles are directed forwards, and others terminate in two or three spines, or are bifid or trifid. The most remarkable instance of these dorsal spined fishes is the genus *Acanthonotus*, where there is a row of ten of them, detached, placed both before the dorsal and the anal fins: more familiar examples are seen in our sticklebacks (*Gasterosteus* Linn.), of which the *G. spinochia* Linn. has no less than fifteen before the dorsal. The spines in the first dorsal fins of the acanthopterygeous fishes are almost always graduated; the first being short, while the second is intermediate between that and the third; which latter (or the fourth) is usually the longest: in particular groups, however, there is always some prevalent modification of this fin, which we shall now notice.

(31.) The *shape* or form of the dorsals is considerably varied: where there are two or three, those which are in front are almost always triangular, while the hinder one is of more equal breadth throughout. In the common cod (*fig.* 2. *a*), the first is acutely triangular, the two next less so; but in *Blepsias*, its representative among the *Canthileptes*, the posterior of the three connected fins is broadest in the middle (*fig.* 2. *b*). In *Trachinus* and its numerous representatives, the first dorsal is short and triangular, while the second is long and narrow (*c*). In the mackerel family, however, where all the fins are subfalcated, both the dorsals are consequently of the same form; but this comparatively is a very unusual structure, although it affords an absolute character to the *Scomberidæ* (*d*). In the sharks, the mullets, and a few others, where the two dorsals are wide apart, both of them are triangular. Nearly all the typical *Gymnetes* have the dorsal fin highly developed; it is here also sometimes particularly broad, with the anterior rays

often excessively prolonged, and ending in spatulate or thread-like filaments. This sudden elongation of the first two or three rays we shall term *falcate;* and it is particularly observable that this shape occurs in nearly all genera which represent the tribe of *Gymnetes* in their own circle. Nevertheless, the secondary modifications of this fin are so numerous, that to describe them all in this place would be tedious and unnecessary. Among the eels, the dorsal is always simple and undivided, narrow, and of equal breadth throughout; and this occurs in almost all the representatives of the apodal order, as *Lepidotus, Ammodytes, Cepola,* and *Ophidium,* among the *Gymnetes; Blennius, Anarhichas,* &c. in the *Gobiadæ; Chimera,* in the cartilaginous order; and *Ophiocephalus,* among the *Macroleptes.* In most of these the dorsal fin unites with the caudal, as in the eels and other *Murænidæ;* while in the *Blennidæ,* or blennies, there is a small interval between them. Lastly, we may notice the long fleshy filaments which in some few genera surmount the spinous rays of the dorsal fin, and produce a very singular appearance. These appendages are mostly found among the *Zeidæ,* or sun-fish, of which the common dory of our coasts is a striking example.

(32.) The ANAL fin may be termed symmetrical to the dorsal; or, at least, its situation on the under part of the tail is analogous to that of the dorsal on the back. It must be observed, however, that this fin is always placed behind the vent, so that the length of the tail, in many cases, is indicated by the length of the anal fin. It is subject to very little variation in form, and still less in construction, for it generally corresponds with the hinder part of the dorsal: it is almost always nearly the same breadth throughout, and without any particular variation in other respects; all the rays, except the two or three first, which are more or less spinous in the most perfect families, are articulated and branched. The anal fin is most developed in the apodal order and its representatives, where we have it some-

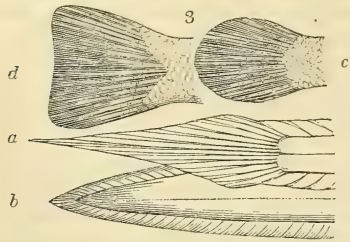
times, as in *Gymnotus* and *Chimæra*, extending nearly the whole length of the fish. This is very observable in the sub-family *Silurinæ*, which also represents the *Apodes*; and we again trace a similar development of the anal fin among the *Blennidæ* and the genera *Cepola*, *Ophidium*, &c.

(33.) The CAUDAL fin alone remains to be noticed. It is, to us, a most unaccountable circumstance, that every naturalist who has hitherto written upon Ichthyology, should have followed each other in paying so little regard to the fins in general, but more especially to this, which (with the tail itself) is as important to the motion of a fish as the rudder is to a ship, or as is the tail of a swallow in directing its flight. That such is the true office of the tail and its fin, among fishes, is too obvious to require being enforced by argument; and yet, while the importance of this member is so fully acknowledged in quadrupeds and birds, that it often furnishes the only decisive generic character, it has hardly ever been considered in this light in ichthyology; and not only whole groups of species, but even of sub-genera, have of late years been described, where the tail is hardly ever mentioned, or, if so, only incidentally. Our own impressions on this subject, after a long and laborious investigation, induce us to consider that, in a natural arrangement of this class, the form of the caudal fin is just as important in fishes as that of the tail in birds; and that it is, consequently, one of the best characters for the determination of natural groups or types that can possibly be found. We view it, in fact, as much more determinate than those slight modifications of the teeth, upon which so many of the modern sub-genera have been founded, to the infinite perplexity of all but the professed anatomist; and, what is worse, to the cutting up and frittering away, as we conceive, of natural alliances, subordinate, in different degrees, to each other. The experienced ichthyologist, well acquainted with the variation of this member, will not fail to observe that the swiftest

swimming fish are all distinguished by a tail more or less forked; and that the most sluggish are invariably characterised by a rounded tail. Now this is precisely what we find in ornithology, where no instance is upon record of a rounded tail and wings being given to swift flying birds, or the reverse. Were we asked to name, from our own experience, that family of fish whose swimming was most rapid, we should hesitate between the flying fish and their enemies, the different species of tunnies, by which they are so frequently pursued: the latter, indeed, would seem to have the superiority, since they frequently overtake the other, upon which they are known to feed; but this superiority lies more, we apprehend, in their greater size and muscular strength than in the absolute power of swimming: it is clear, in fact, that if the strength of the flying fish did not fail after a long chase, the bonatos or tunnies could not overtake them, any more than the dog could outstrip the hare. In both instances the superiority of speed lies with the pursued, while that of muscular strength is with the pursuer; thence the latter qualification, in the end, triumphs over the former. Now the whole of the *Scomberidæ*, or tunny family, have the tail more deeply forked than any other fishes, perhaps, in the entire class; for not only are the two lobes deeply cleft, but in most instances they are actually divided; and they are further provided with two additional finlets on each side, by which the rapidity of motion is doubtless accelerated: this is further increased, in many groups of this family, by a prominent fleshy keel which projects on each side, near the base of the caudal fin, and parallel to the lateral line: these ridges are obviously intended to cut the water on each side, and they are only found among those families we have arranged in the tribe of *Macroleptes*. Forked tails are only found among the two great divisions of osseous fishes, and a few of their representatives; for those of the sharks, when they approach this form, are more properly lobed or emarginate in the middle, the lobes themselves

being rounded. The *Balistidæ*, the most perfect of the cheloniform fishes, and which represent the spine-rayed order (*Acanthopteryges*), consequently present us with nearly all the modifications of fin observable among their prototypes; but in the whole of the remaining families, and the entire order *Apodes*, where we have the most sluggish of all fishes, as the *Chironectidæ*, the *Lophidæ*, *Cyclopteridæ*, *Muræenida*, &c., not a solitary example occurs of a forked tail, much less of those additional helps for speed just noticed, which have been given to the *Scomberidæ*. If we carry our inquiry into the minor groups or families, we shall find the same determinate prevalence of one set of characters in the fins, running through each particular group. Numerous instances of this will be brought before the reader, for the first time, in the progress of our work. Having now adduced sufficient reasons, as we imagine, for the opinions above expressed, we may at once proceed to notice the different forms observable in this fin.

(34.) The caudal fin presents every modification between a perfectly lanceolate shape, where the largest rays are in the centre (*fig. 3. a*), to that of a deeply forked one, where the central rays are so short as almost to become obsolete, giving the tail an appearance of being divided into two parts. The first of these forms is shown in the genus *Cepola*, and its representatives the Indian gobies; the second runs through the whole of the mackerel, tunny, sword-fish, and a large proportion of the *Zeidæ*, or dories. Besides these, there is also a third, peculiar only to two or three genera, where the tail may be said to be doubly forked; a few of the central rays being lengthened nearly as much as



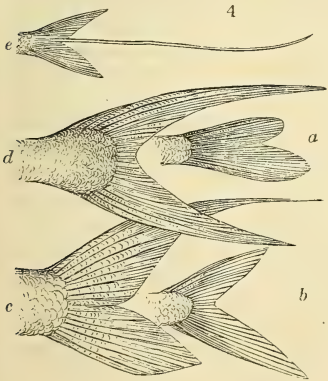
the external ones, so that they form a lobe on each of their sides — one above, the other below. Where such numerous gradations occur, it is impossible to define with strictness the limits of our definitions; we may, nevertheless, arrive at some degree of precision, by considering each of these forms as presenting the following modifications: — A rounded fin is either lanceolate, oval round, even, or truncate. On reaching this latter, we may draw an imaginary line, and enter upon the fork-tailed division. Truncate fins pass into those which are slightly crescent-shaped; they next become lunate, forked, lobed, and, finally, emarginate; while these latter, again, pass into rounded fins: the highest development of each of these is seen in the lanceolate and the forked; the other modifications gradually recede from each other.

(*35.*) We shall now endeavour to define each of these forms.—1. *Lanceolate,* so named from the shape bearing a resemblance to the head of a lance: the longest ray is in the centre, and stands singly; all the others are in pairs, diminishing, more or less gradually, in length, until those that are external become the shortest. Nearly all the species of *Cepola* (*fig. 3. a*) possess this character, but it is by no means frequent, and is chiefly seen in that genus, *Gobius*, and in *Sciæna pama* (Cuv. pl. 101.).—2. *Oblong oval:* not quite so long in proportion as the last; the middle is not pointed, and the shape is that of the smaller end of an egg. This form may be called a highly developed state of the next, and is confined to few examples. — 3. *Round:* the fin is of moderate size, always shorter than the last, and the extremity describes the segment of a circle. This is the most common shape in this division, and pervades all the flat fish (*Pleuronectidæ*), a few of the rocklings (*Motella* Cuv.), all the gobies (*Gobiadæ*), the genus *Syngnathus*, &c., none of which are capable of long sustained swimming: the degree of roundness varies; but we still retain the name to all such fins as have the central rays in any degree longer than those on their sides. — 4. *Even:* the majority of the rays are

of equal length, the central ones not exceeding the others, while the outermost ones are rounded at their angles only. Many of Cuvier's genus *Serranus* have this fin, also nearly all the sticklebacks (*Gasterosteus*), *Sciæna aquila* (Cuv. pl. 100.), *Blepsias* (Ib. 90.), *Uranoscopus, Priacanthus, Hemitripterus,* &c. — 5. *Truncate:* when the extremity of the fin appears to be abruptly cut off, so that the external rays are just as long as those in the middle, and the angles are not rounded, as in the last. *Zeus* and *Trachinus* may be cited as the most familiar examples of this form, which is only distinguished from the next by the marginal extremity of the fin being in no degree concave or crescent-shaped, or, in other words, not having the central rays shorter than the external: it must be observed, however, that fins of this description can only be detected when extended; for when closed, the margin generally has the appearance of being slightly concave.

(36.) *Forked* caudal fins are as much, and even more, varied than the last. The incipient development of this structure is seen in such as have the marginal extremity slightly *concave*, as in the majority of the *Triglidæ*, or gurnards, the angles being pointed, and the interval between them slightly hollowed out, so that the central rays are shorter than the external ones. *Trachinus radiatus*, according to Cuvier (pl. 61.), has a concave fin, although in the common species of the Mediterranean it is completely truncate. This is a very prevalent form, and several examples occur in the subfamily of the *Sciæninæ*, as *Leiostomus*, some *Corvinæ*, &c. — The *lunate* shape is on the same principle as the last, but the concavity of the margin is much deeper, and the two extremities are prolonged, often (as in *Naseus*, some of the sub-genera of *Acanthurus*, &c.) to an excessive length, in the shape of filaments. *Forked* caudals, properly so called, are of two kinds: in one, the divisions are equal (*fig.* 4. *d*); in the other, unequal (*c*). The most typical of the first form, as before intimated, is universal among the *Scomberidæ*, or

mackerel, where the middle of the fin is cleft to its base, or very nearly so; and each division is falcate, as in the tunnies, or somewhat lanceolate, as in the common mackerel. This form, so prevalent among the genera of the *Microleptes* (or that tribe which includes the whole of the *Scomberidæ*, *Zeidæ*, &c.), hardly exists in the pre-eminently typical tribe of *Macroleptes*. These latter fishes, on the contrary, have a simply forked caudal; that is, the lobes are not attenuated, and the central rays are nearly equal to half the length of the external ones. This structure is the most general in fork-tailed fishes, and is generally constant in natural groups, of which the *Sparinæ*, the true perches, and several others, afford ample proofs. The most extraordinary development of a simply forked tail, yet discovered, is to be found in the *Macropodus venustus* (Cuv. pl. 197.), where the length of this fin is nearly equal to that of the body: and this is the more remarkable, since, in no other genera of its own circle, is the caudal of this form; a clear indication that it is the rasorial sub-genus. Sometimes, as in *Nomeus* and *Hoplostethus*, the caudal, although deeply cleft, has the two divisions rounded; but this form is very uncommon. — *Unequally forked*, is when one of the divisions of the fin is larger than the other: our English sand-lance (*Ammodytes*) shows this very well (*fig.* 4. *a*); and it is likewise found in all the flying fish (*b*), and the greatest part of the sharks and sturgeons. The caudal fins, however, of these latter families are altogether peculiar: the rays are by no means symmetrical, so that the upper



lobe of the tail is not formed, as in ordinary fishes, by rays, but by the terminal vertebræ, round which the fin is short; while the other, or lower lobe, often irregular, is alone composed of rays. No other fishes, yet discovered, possess this sort of caudal fin, nor is there any thing analogous to it among the osseous or semi-cartilaginous orders. Another modification of the forked structure occurs in a very few genera, where there are two divisions, or rather sinuosities, in the terminal margin, analogous to the double fork seen in one or two birds of the *Caprimulgidæ*. Finally, this structure blends into the rounded form in such fish as have the *even* tail already described, but with the middle rays very slightly shorter than the outer; so that the margin becomes widely notched, or sinuated, as seen in several of the salmon family, and many others.

(37.) In some genera the caudal fin is either *indistinct* or *obsolete*. The first appellation may be given, when the fin is so united to the dorsal and ventral that there is no perceptible difference between the rays of either: such is the case in the greater number of the eels and congers, in the genus *Ophidium*, in certain silures, or cat-fish (*Siluridæ*), and in several other anguilliform types: in some these three fins form an acute point, as in *Ophidium, Synbranchus*, &c.; or a rounded one, as in the lampreys (*Petromyzon*), and many of the soles, and other *Pleuronectidæ*. The caudal fin may be also termed obsolete in most of the *Raidæ*, where it either assumes the form of one or two small lobes, or of merely a long narrow membrane bordering the lower extremity of the pointed filiform tail so common in this family. The caudal, however, is completely obsolete in such genera as *Trichiurus;* for in them the body terminates in a long slender process resembling a filament. In *Trichiurus, Chimæra*, and some *Syngnathi*, the tail is destitute of either a terminal or lateral fin; and the same is observed in many of the sting rays (*Tryglinæ*): but in *Gymnotus* the under part of the tail is margined by a continuation of the anal fin which reaches to the

point. One or two extraordinary departures from the ordinary form of this fin may here be noticed, but they are mostly confined to single genera. In *Trachypterus*, the fin, although large and truncate, is mounted vertically upon the point of the tail, so as to form an angle with the line of the body. This structure is altogether unique among fishes; for it does not exist in the neighbouring genera *Argycthis* Sw. and *Nemotherus* Raf., whose tails are situated as in ordinary fishes. The other modification belongs to Cuvier's *Serranus phœton* (*fig.* 4. *e*): the tail is forked; but from the centre or deepest part of the cleft springs a long filamentous ray, near three times the length of the fin itself,—a structure of which, as yet, we know of no parallel.

(38.) Having now brought before the reader (what has never hitherto been done) an enumeration of nearly all the different forms observable in the fins of fishes, we shall conclude this part of our subject with an attempt to generalise, in some degree, the facts thus brought together, in order to show that the results thus obtained will correspond in some remarkable points with the locomotive organs of birds. In the first place, it must be remembered that these organs are more numerous in fishes than in any other vertebrated animals. this is the necessary consequence of their being the fissirostral or aquatic type of the vertebrated circle; which type, as we formerly explained, invariably possesses, in this circle, the greatest powers of motion. The ornithologist is quite aware of this; but it may be as well to inform the ichthyologist, who may not have studied that branch of zoology, that the swallow, goatsucker, tern, albatross, and kite,—the swiftest flying birds that are known to exist,—are all of them of the fissirostral structure, whether by affinity or analogy: and thus do we find this law pervading the class before us,—a class which may be said to be in perpetual motion; for although a quadruped can lay down to repose, and a bird can roost on its legs, it seems difficult to imagine

how a fish can rest without any motion of its fins*,—more especially those which habitually live in the open sea.

(39.) We have already shown in what manner the FINS of fishes represent the organs of motion in birds. Now, in all these latter, superior powers of flight are invariably indicated by the great length and pointed structure of the wing; and this power among birds is at its maximum when the tail, also, is forked: the common house swallow shows this in perfection. Now this is precisely analogous to what we see among fishes: all those with pointed pectorals swim much faster than those which have this fin rounded; an inference which does not merely rest on analogical reasoning, but from the remarkable fact, that the far greater majority of those fish which have pointed pectorals habitually live in the open ocean, or far from the shelter of the shore. We know not, at this moment, of any freshwater genus, wherein the pectorals fins are decidedly pointed; while, if we look to the oceanic families of the *Zeidæ* and *Scomberidæ*, and even the majority of the *Percidæ* and *Chætodonidæ*, we shall find very few instances of the pectorals being rounded. But if, in addition to this pointed form, a fish has the tail also deeply forked, and the pectoral fins falcated or curved, as are the wings of the goatsuckers and humming birds, then we have the highest development of the powers of swimming possessed by this class. Hence it is that the mackerel, the sword-fish, and the tunnies—more especially the latter—are, together with the flying fish, the most perfect of all swimmers. Every one who has seen the astonishing rapidity with which the tunnies will sometimes play about a vessel in the Atlantic Ocean, when sailing at its utmost speed, will be perfectly convinced of this: for although their rapidity, for a time, may not equal that of the rays, it is quite evident that they have a vast superiority over the latter in their adaptation for sustaining swimming; the rays, indeed, being obviously ground-fish, or of those families which seek their prey at the bottom of the sea. The

* Except the flat fish, which, of course, lie on the ground.

tunnies, of which the bonitos and albicores of seamen are only different species, will sometimes, in a stiff gale, play about a vessel in full sail, with as much ease as if she was perfectly still — one moment they will be near the stern, while the next, as if by a single dart, they are many yards ahead of the bowsprit: this we have repeatedly witnessed; and the thought then struck us that no fish, by any possibility, could move more rapidly. In comparing, therefore, the functions of the pectoral and caudal fins of fishes to the wings and tails of birds, we find they are perfectly analogous, and that their importance, as furnishing generic characters, is equally great.

(40.) It is somewhat remarkable, that although many instances occur among swift-flying birds where the wings are pointed and the tail rounded, yet in the class of fishes, the shape of the pectoral and the caudal fins are almost always symmetrical; that is to say, the caudal is forked in the same proportion as the pectorals are pointed; nor does an instance at this moment occur to us where the pectoral is pointed and the caudal rounded, or the contrary: hence we may infer that the caudal fin in fishes is more important in its offices than is the tail in birds, and this is an additional argument in favour of the importance we attach to this member.

(41.) A comprehensive view of the coincidences in the formation of the dorsal and ventral fins in genera widely distinct in affinity from each other, will lead the philosophic naturalist to suspect that these may offer one of the best clues for determining the analogical relations of widely separated groups. This intricate subject has claimed much of our attention; and although, from its nature, we have been obliged to leave it unfinished, the progress we have made seems to sanction the following observations: — It would appear that in every one of the tribes composing the two orders of osseous fishes (the *Acanthopteryges* and the *Malacopteryges*), the two chief divisions are characterised, the one by having the dorsal fin single, while in the latter it is double, or at least deeply cleft: in another

division the pectorals are larger than usual, and the ventrals often remarkably developed: in a fourth, these latter fins are quite the reverse; they are either small, very imperfect, or altogether wanting, while the dorsal is long and often very broad: finally, there is a fifth form where the first dorsal is short and triangular, and the second long and narrow, as in those two well-known genera *Trachinus* and *Uranoscopus*. Numerous examples of the prevalence of these forms, following each other in a natural series of affinity, may be traced in the synoptical definitions of the arrangement we have made of this class; and although the preceding remarks are more particularly drawn from the two typical orders, instances are not wanting to show the same tendency in the more incomplete or aberrant orders.

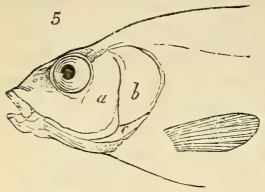
(42.) We may here explain the terms by which we propose to designate the different forms of the fins, and of their relative situation. The true length of a fin should probably be reckoned from the base to the tip of its rays, while its breadth would be estimated by the horizontal space it occupied between one extremity of the body and the other; but this terminology, however abstractedly just, would be in complete opposition to the terms we apply to the figure of the fish itself, and might lead therefore to some perplexity. We may take the eel as an example: we should say that this fish is very long, and justly so; but although its dorsal fin extends to near its entire length, we must describe this fin, in accordance with the foregoing rule, as *very short*, because the length of the rays (not the fin itself) is really so; while, by the same rule, we must term the body very narrow, and, the dorsal fin very broad. To common apprehension, these terms would seem to contradict each other: and, in truth, the subject is beset with some difficulty. It seems to us, however, that by looking to the fin itself, instead of its rays, we may get a greater uniformity of terms than by any other rule. Thus, we should describe the dorsal fin of the eel as very long, but very narrow or low; and that of the

Pteracles trichipterus Cuv., as very long and remarkably broad.

(34.) The number of RAYS of which the several fins are composed, affords one of the best characters for specific distinction; for although it has been said that they vary in individuals of the same species, we must confess that this opinion has not been verified by our own observations, — and they have neither been few, nor partial, nor taken from preserved specimens. We are more disposed to believe that such differences are more apparent than real: first, because in many instances, when the rays are very small and close together, or very numerous, we have found it almost impossible to attain perfect accuracy in this respect, except by repeating the examination several times, even on fresh specimens; and secondly, because the fins of many of the ground-feeding families are so thick and fleshy that the number of rays cannot be distinctly counted. The eels, the *Gadiadæ*, the *Siluridæ*, and several other thick-finned families, are familiar instances of this; but very few will be found among the spine-rayed groups, where, from the membrane being thin, the rays of the dorsals, ventrals, anals, and even the pectorals, may be numbered with accuracy.

(44.) The external covering of the GILLS, and more especially their aperture, are of great importance, and require to be further noticed. The use of the gill-cover, or *operculum*, is obviously to protect the gills themselves, and, at the same time, to admit the egress of the water taken in by the mouth: in the majority of typical fishes it is moveable; for, although composed of bony plates, these plates are articulated or jointed at their sutures by a membranaceous skin which acts as a hinge. Properly speaking, the *operculum* consists only of three pieces, which are attached to the cheek-bone, called the *pre-operculum* (*fig. 5. a*): of these three plates, the upper is more especially termed the *operculum*, and it is always the largest; the next is the *sub-operculum* (*b*); and the third, which is very small and sub-triangular,

is the *inter-operculum* (*c*), because it fills up the interval between the base of the *pre-operculum* and the *sub-operculum*. These distinctions will be rendered more intelligible by the annexed figure, which represents the head of the common tench. These bones are either smooth both on their outer surface and their edges, or they are armed, in one or both situations, either with spines or prickles, or very fine dentations like the teeth of a saw; and these modifications are of great importance in determining generic groups. The hinder margin of the entire *operculum*, or gill-cover, is generally bordered by a thin membranaceous skin, for the purpose of closing the opening of the gills more effectually: this skin is a continuation of that which supports the branchial rays, and these latter commence at the bottom of the head, adjoining the throat; and the number of these rays are considered indicative of generic peculiarities. In many groups which possess gill-covers, the plates are either immoveable, or are so completely concealed under the skin that they are not to be detected except by dissection. In such instances, the aperture becomes so small as to be analogous to the spiracles of the cartilaginous tribe; it assumes, in fact, the appearance of a slit, and is then termed a spiracle. This character pervades the whole of the aberrant tribes of our present arrangement, and even extends to such osseous fishes as represent them in their own circles. It seems to be a general law, that those fishes which have the gills highly developed, and the aperture very large, like the herring and mackerel, very soon die on being taken from the water; while those, on the contrary, as the eel, which breathe by spiracles, live for a considerable time on being exposed to atmospheric air. It is among such that we find



those crawling species before alluded to, which voluntarily quit the water in search of new habitations.

(45.) The TEETH of fishes, as before remarked, are varied in the most surprising manner in regard to their situation, but less so in their construction; and these instruments are far more numerous in this than in any other class of animals. They are not confined, like those of quadrupeds and reptiles, to the two jaws, but are often disposed in all parts of the mouth. The maxillary teeth are those which are most external, and are placed on the jaws, properly so called, in quadrupeds; and they correspond to the cutting edges of the two mandibles in birds. Parallel to the upper jaws, internally, are the palatine bones, which often support other teeth: between these bones, and in the centre of the palate, is the vomer,—a name given to that bone which forms the roof of the mouth; and this also is frequently armed with teeth, even when the jaws and lateral palatine bones are completely smooth, as in the instance of the common carp, tench, &c.: the tongue, also, is sometimes armed with other teeth, as in the pike, &c.: sometimes all these are so thick and numerous, that they seem like a dense forest of teeth, capable of crushing the most minute substance. To describe the different forms of these teeth would be almost impossible: they are in general more or less pointed; in the herbivorous fishes they are formed for the purpose of pressing; and in such as feed upon testaceous animals, they are so much rounded as to be analogous to the molar teeth of quadrupeds. In the *Siluridæ*, and other genera, they are so delicate and flexible as to resemble the pile of velvet: hence we may term such teeth *setaceous*. In the sharks they are compressed, and serrated on their sides; while in the Rays they are round, and placed in the manner of paving stones or mosaic: such teeth are therefore termed *tessellated*. In many of the genera (as *Laurida*) they are moveable at their base in an inward direction, to admit a free passage to what is swallowed. Among the cheloniform fishes, the absence of true teeth is supplied,

as in their prototypes, by the sharpness of the jaw-bones, which are remarkably strong: the analogy, however, here ceases; for the jaws of the true chelonian reptiles are entire; whereas those of the *Balistidæ* are divided in such a manner that they wear the appearance of being like the true and distinct teeth, placed in a single row, of ordinary fishes. Finally, we perceive sub-genera, and even species, as they are now classed, scattered among the greatest number of these toothed races, which have the jaws entirely smooth; a clear proof, if any other were wanting, that *genera* built entirely on these organs are more likely to be artificial than natural; indeed, we have only to look to those among the *Siluridæ*, as they stand in the most recent systems, for a justification of this opinion. It frequently happens that in natural groups, like the last, the teeth offer no variation of the least importance; while in others they are scarcely the same in two species, and vary in the most remarkable manner, even in the same fish, at different stages of its growth. This is particularly observable among the salmons, and even in the family of sharks. The value of a zoological character is well known to be proportioned according to its prevalence in groups or individuals, which, in every other character they possess, show a clear and unquestionable affinity. Thus the prevalence of the spiny or of soft rays in the osseous fishes indicate, with other peculiarities, the two great typical divisions; and thus, from its prevalence among families and genera, clearly related, we infer its primary value. But when, in another group, we observe the teeth vary in almost every third or fourth species, although their characters in other respects are precisely the same, it is quite clear that we must look for some other marks of discrimination, possessed by *all* these individuals, whereby to preserve in our systems that bond of union which we see in nature. Among the sturgeons, for instance, we have some species with teeth, and others without; yet there is no other difference. Still more

remarkable are the variations in the teeth of M. Cuvier's genera *Pimelodus* and *Bagris:* he himself observes this; and yet these two groups are attempted to be characterised by their teeth alone. Numerous other instances might be named; so that the only conclusion we can come to is, that as no organs vary so much among fishes as the teeth, so do they offer the most uncertain characters, *when taken by themselves,* for designating natural groups. For these reasons, we consider such characters inferior to those drawn from the fins, the gills, the eyes, the body, and the scales.

(46.) The LATERAL LINE, where it exists, as in the more typical groups, deserves much attention: the scales of which it is formed are always of a peculiar construction,— being perforated in the middle for the free issue of that mucous substance which is so prevalent among fish, and which is secreted in certain glands beneath: these scales are generally of a different shape from those of the body; and they have been recently employed by our best ichthyologists as additional aids for discriminating species, which otherwise bear a close resemblance. Sometimes, as in the family of *Scomberidæ,* the scales of the lateral line are raised and carinated, so as to present a prominent edge like that of the sharp ridge of a triangle; while in others they assume the form of spines or prickles: then, as to the direction, it is either straight, arched, broken, or sinuated. In some of the Indian *Siluridæ* it is double; and in many genera it cannot be distinguished.

(47.) Many of the soft-finned fish are provided with *cirri,* or barbels, placed round the mouth: these are soft fleshy processes, and are supposed, with every appearance of reason, to be employed both as organs of touch, and also of allurement to their prey. We concur with Mr. Yarrell in believing that all cirrated fish are ground-feeders, that is, seeking their food close to the bottom. We may also remark, that such genera as have these appendages very highly developed, as in nearly all the *Siluridæ,* or cat-fish, they are employed

to attract others, upon which they prey. The cat-fish, safely screened from observation in the natural hollows or holes of the bank, throws out his long *cirri*, which, being flexible, may well be taken for worms by other smaller fish, which are thus brought within reach of their true owner. Among the cod-fish they are much shorter; and in the tench family they are very slightly developed. We find them, in a slight degree, in the cartilaginous genera of *Acipenser*, *Squatina*, and *Crossorhinus*; but in this latter they assume the form of short flat processes, so that they may here perform a different office. Perfectly analogous to these cirri is the long appendage rising from the nose of the frog-fishes, composing the genus *Lophius* of Linnæus. It is probable that these amphibious-looking creatures are the most imperfect swimmers in the whole class; and being carnivorous, this inaptitude for pursuing their prey is made up to them by a very long filament, rising from the head, and terminated by a flat spoon shaped enlargement, so as to bear a ludicrous resemblance to a fishing-line with a bait at the end: the fish lurks in its hole, and throws out this natural line, and thus attracts its prey. Its vulgar name of fishing-frog is, therefore, peculiarly expressive; for it not only angles, but it is of that type which represents the amphibious frogs among the aberrant fishes. Having now laid before the reader the chief characters of structure by which the different tribes, families, and genera of fish are distinguished, we may briefly touch upon the senses they seem to possess, and then enumerate some of the most interesting points of their natural history or economy.

(48.) The SENSES of fishes are much less developed than those of quadrupeds or birds. Some of these faculties have been already incidentally mentioned, to which it is only necessary — in such a rapid view as we are now taking — to add the following: — The sense of touch is very partially developed, for it is difficult to understand how it is possessed by those families which

are destitute of cirri: the lips, indeed, of some few genera are thick and fleshy; but analogy would lead us to believe that this peculiarity had a greater reference to taste than touch. It seems, however, that nature compensates her partial denial of this sense by increasing that of sight. The eyes of nearly all the spiny-rayed fishes, very few of which are provided with cirri, are particularly large; and this circumstance alone would lead to the conclusion that the faculty of sight is highly developed in such groups. It may be observed, on the other hand, that nearly all the soft-rayed genera, that are provided with cirri, have the eye comparatively very small: and such is also the case in most of the ground-fish; witness the eels, the flat fish, the sharks, skates, and lophians.* The mackerel, the herring, the *Spari*, and the dolphins, which are pelagic, or roaming for the most part in the wide sea, have all large and brilliant eyes; while a few others, which there is reason to believe live almost entirely in the profound depths of the ocean, have eyes even still larger than the last. This brings us to the sense of smelling, which there is equal reason to believe is very great; for the nostrils generally have a double opening on each side, although both lead to the same canal; while the internal nerves connected with the nostrils are very large, and occupy a considerable space.

(49.) Fish are exposed, on all sides, to the approach of enemies, from whom there is rarely that facility of shelter afforded in the open sea which is enjoyed by land animals. A highly developed state, therefore, of the organs of sight and smell appears absolutely necessary to them, not only for their own safety, but also to discover the food, whether animal or vegetable, upon which they subsist; with these qualities the faculty of touch is hardly required, and we consequently find it either very partially or, to appearance, not at all given. Inductive reasoning, again, teaches us

* We propose this designation for the *Lophiadæ* and the *Chironectidæ*, forming the Linnæan genus *Lophius*.

to infer that the sense of taste is very slightly possessed by fishes. The structure of their teeth, with few exceptions, shows that the food is generally swallowed in an entire state, since it is so found in the stomach; and very few instances occur of fish having cutting or grinding teeth. Besides, it has been justly observed by Mr. Yarrell*, that from being obliged unceasingly to open and close the jaws for the purpose of respiration, fishes cannot long retain food in the mouth when shut; the substance, if of small size, must be swallowed quickly. The structure of the tongue tends to the same conclusion; we believe it is in all cases small, hard, and generally cartilaginous, and consequently incapable of conveying that exquisite taste of their food enjoyed by all the quadrupeds, and a few of the birds.† Fishes have been supposed destitute of the faculty of hearing, but this is disproved by many circumstances. It is known as a well-authenticated fact, that the Chinese, who breed great numbers of goldfish, call them together, at the time of feeding, by a whistle; and the same mode of summoning other species by a noise, in aquatic preserves, are upon record. There are, indeed, no external indications of ears in any fish, excepting the rays, where there is a small spiral cavity (placed before the *meatus externus*, and covered by the common skin), which may be analogous to the external ear of other animals. The internal labyrinth, however, is always present, although much less complicated than in the more perfect *Vertebrata*.

(50.) The *vitality* of fishes may here be adverted to. There is not sufficient evidence to show us the average age of the generality of fishes; but some well authenticated facts regarding carp, and some other domesticated fish, tend to prove that the former have reached to a century. Cartilaginous fishes, from the nature of their bones, continue to grow all their lives; and as many of these, particularly the rays, habitually live in the deep recesses of the ocean, and thus seldom run the

* Yarrell's British Fishes, i. xvii.
† Particularly the whole family of *Anatidæ*, or ducks.

chance of being captured by man, we may probably attribute their enormous and almost incredible size to their great age. Several genera, like the *Ophicephali* and eels, are so tenacious of life, that they are well known to live under sufferings which, to other animals, would be the most cruel torments; while others die almost the minute they are taken out of water. Many fish show their tenacity of life in other ways: some can not only exist, but actually breed, in hot springs of various countries, whose temperatures vary from 80° to 120° Fahr. But a statement by baron Humboldt, on this subject, is still more surprising: he mentions, that during his researches in Tropical America, he found fish thrown up alive from the bottom of an exploding volcano, along with water so hot as to raise the thermometer to 210°, being two degrees only below boiling. Considering this excessive heat, it is, we think, too much to suppose that the water in which these fish habitually resided was always of such a temperature. It is a well-known fact, that springs in the vicinity of volcanoes are very often considerably heated *before* an eruption takes place; and until we are in possession of further evidence on this point, we believe that such was the case in the present instance: the internal fires, in all probability, had greatly heated the water previous to its having been expelled from its natural basin, before the increased heat had killed the fishes; a supposition much more probable, it appears to us, than that fishes would live and sport in a fluid whose temperature would be sufficient to prepare them for the table. We have already alluded to the singular faculty possessed by the *Ophicephali*, and some other fish, of crawling upon dry land, and thus living in an element not their own: it is well known that the tanks or isolated reservoirs of water in the East Indies are often completely dried up during summer; and yet, when they become again filled during the rainy season, fish are also found in them. This singular fact appears to be accounted for very satisfactorily by Mr. Yarrell: the impregnated ova (he observes) of the fish of one

rainy season are left unhatched in the mud through the dry season, and, from their low state of organisation as ova, the vitality is preserved till the occurrence and contact of the rain and the oxygen of the next wet season, when vivification takes place from their joint influence. "If this solution of the problem," continues our author, "be the true one, it points at once to what perhaps may be effected after a few experiments,—namely, the artificial fecundation of the roe, the drying of that roe (or of other roe naturally impregnated) sufficiently to prevent decomposition, and its possible transportation to, and vivification in, distant countries."

(51.) Contrasted with these instances of fishes living in heated water, there are numberless others proving their vitality even in a frozen state. It is even said, that in northern latitudes, advantage is taken of this circumstance to transport eels and perch from one locality to another. It must not be supposed, however, that this vitality exists in all species inhabiting the same latitudes; and we can illustrate this idea by a fact which has unfortunately come under our personal observation. Upon the breaking up of the long and severe frost of this winter (1837-8), we have had the mortification of seeing the dead bodies of between thirty and forty fine tench floating on the surface of a pond in the garden, into which three or four pair had been put four years ago. The pond is of rain water, with a soft muddy bottom, which has a depth of from two to four feet, and is fringed with many aquatic plants. Abundant shelter was thus afforded for the fish; and yet there can be no doubt, we think, that they have all been killed by cold. The people about the place assert that this mortality would not have happened, had holes been broke in the ice for the admission of air: but were this absolutely necessary in all cases, it would follow that the tench of all such ponds as had not been opened would have been likewise killed.

(52.) The fecundity of fishes is something so prodigious as to stagger the belief of ordinary minds. When we say that a single female lays hundreds of thousands

of eggs in a single season, the statement is not exaggerated; and yet the waters are not more densely populated now than they were in the last generation. The reason appears to be this: all fish are more or less carnivorous, and feed not only upon other marine animals, but upon each other. To supply this latter food in sufficient quantity, as well as to provide against other casualties, Infinite Wisdom has given to these His creatures a power of reproduction without parallel in the animal creation: were it not so, the seas would be depopulated of all other inhabitants, or thousands would perish by the most cruel of all deaths, starvation: as it is, a momentary pain is all that can be experienced by a fish which is seized and swallowed in an instant by a larger one: and although this is probably the fate of countless millions, little or no corporeal pain, in the true sense of the term, can be experienced by a death so instantaneous.

(53.) The natural history, or, in other words, the habits and economy of this class, in comparison to that of terrestrial animals, is involved in great obscurity, and presents little of that popular interest attached to the economy of birds and quadrupeds. Nevertheless, the history of such fish as the salmon, herring, mackerel, &c., is highly interesting both to the naturalist and the general reader: they form an important part of our subsistence; while great numbers of men, and large amounts of capital, are engaged in their capture. We should have regretted that our limited space would not allow of entering into all these details, could we not refer our readers to the two interesting volumes already cited on British Ichthyology.

(54.) The geographic distribution of this class has been very much neglected; for, with the exception of the valuable observations of colonel Hamilton Smith, we are unacquainted with any author who has written upon this interesting and important subject. Our own observations, made in different parts of the world, tend to confirm nearly every circumstance mentioned by the above-named able and accomplished naturalist. Nevertheless, from

many facts that could be mentioned, we believe that the geographic range of the certain genera and species is much more definite than has hitherto been supposed. Several of the Mediterranean species, which are universally believed to inhabit the seas of Tropical America, we consider to be truly distinct; and similar differences may be detected even between the fish of Northern and of Southern Europe. One great cause of the supposition that the same species so frequently inhabits widely separated shores, is the fact that this class is less affected by temperature than any other vertebrated animals; and it is therefore inferred that the similar species may exist both in temperate and tropical latitudes: this may seem to be true; but then the question arises, whether their peculiar food is also found in the same seas? The majority of fishes are carnivorous; and it may be said, that as small fish are to be found every where, the larger can prey upon them; but such is not precisely the fact. We know that every family, nay, almost every species, of insectivorous birds, feeds only upon certain genera of insects; and all we know, both from fact and analogy, favours the idea that carnivorous fishes are limited in their choice of food by similar laws: indeed, this belief almost amounts to absolute certainty, when we consider that different tribes are generally found restricted to different depths and descriptions of sub-marine soils. This fact has been so ably illustrated by colonel Smith, that it need not be insisted upon in this place. Now, it is quite evident that this allotment of particular depths or localities is an instinct given to them for frequenting those situations, and those only, where they are sure of finding their congenial food. We may even suppose that such as live upon testaceous *Mollusca* and crustaceous insects are more limited in their range than those which live upon young fish, because the former animals are more limited in their distribution than the latter: again, the soft pelagic *Mollusca* are more widely distributed than shells or *Crustacea;* and, therefore, those fish which fed upon them would enjoy a greater range than

others. That certain families, and even genera, are strictly limited, so far as we yet know, to the shores or rivers of particular countries, is unquestionable; and of this the family of the *Siluridæ*, upon which we shall subsequently dilate, offers several singular proofs. The most typical belong only to the equinoctial rivers of America; while nearly all the sub-typical, that is, of the *Pimelodinæ*, occur in the great rivers of India: we suspect, even, that such of these latter as have been found in America will prove to be distinct geographic sub-genera. The whole family may be considered tropical; for the only species yet found in the rivers of Europe is of a very aberrant form, and is as much related to the aberrant *Gadiadæ* as to the typical *Loricarinæ*. The *Gadiadæ*, or cod-fish, again, seem to supply, in cold and temperate regions, the place of the *Siluridæ:* they are most abundant on the confines of the Arctic seas, and gradually diminish as they approach the southern shores of Europe, where the species, although many, are almost all of the aberrant forms; and yet not one example of the whole family was observed by us in the Brazilian seas. As we shall occasionally touch upon this subject in the succeeding pages, further instances need not be mentioned in support of our opinion. The fact, we have no doubt, will ultimately be established, that fishes are nearly as much limited in their geographic distribution as birds; and that temperature alone has very little to do in regulating this distribution.

CHAP. III.

A SKETCH OF THE HISTORY AND BIBLIOGRAPHY OF ICHTHYOLOGY, WITH SOME REMARKS ON COLLECTING AND PRESERVING FISH.

(55.) A LENGTHENED exposition of the rise and progress of ichthyology is not suited to the present publication, and would occupy more space than we could devote to this department of zoology; but a few general remarks on this subject cannot well be dispensed with. Like all other sciences, its progress has been unequally progressive, according to the degree of attention or of neglect it has received in different periods.

(56.) The ancients appear to have paid more attention to this class of animals than any other, and have left us the names of nearly 200 different species, chiefly inhabiting the shores of the Mediterranean—the majority of which were then, as now, in request as food for the highest as well as the lowest ranks. After the revival of learning, and in the middle of the sixteenth century, ichthyology, as a science, first began to assume a new birth in the writings of Belon, Salviani, and, more especially, Rondelet, better known under the name of Rondeletius. It is a most fortunate circumstance that these early writers bestowed so much labour in determining the names by which the Mediterranean fishes were known to the ancients, which they justly considered of much importance. Immense labour, research, and doubtful disputation have thus been saved to the moderns; while, on the other hand, had they attempted to describe, in greater detail, the internal and external structure, the probability is, considering the age in which they wrote, that their books would have been utterly useless to modern science. As it is, however, they are actually useful, and often essential, not only as high authorities for the no-

menclature of antiquity, but for the characteristic, although often rude, accuracy of their figures. Those of Rondeletius, more especially, are in several instances more faithful than many that are inserted in our modern publications; and to this day they continue to be quoted as authorities by our best writers. The credulity of the age, indeed, was in some degree shared by these twinkling stars of light in the returning dawn of knowledge; for Rondeletius has left us pictorial representations of certain cunning fabrications, called the monk-fish, the bishop-fish, and the sea lion. It is singular that these three fathers of science flourished at the very same period — all three having published their works between the years 1553 and 1558. They seem, however, to have left no disciples; for during more than a century ichthyology appears to have lain dormant, until, in 1686, it was again revived by the labours of our illustrious countryman, Willughby, the patriarch of zoological science in Britain, in conjunction with his tutor and companion, the learned and pious Ray. When it is considered that no less than 186 folio copper-plates form the pictorial volume of Willughby, in an age when natural history had not a twentieth number of the votaries who now profess to be so, we cannot but feel surprised at what may be called the "spirit" of the booksellers of that age, in undertaking the publication of a work which none of our modern bibliopoles would think of venturing upon. This volume is altogether not only highly curious, but even valuable. The figures are very unequal, since it seems to have been intended to comprise a complete collection of all known fish: hence those found in the volumes of Rondeletius, Salviani, Marcgrave, &c. are faithfully copied; but these are interspersed with a large number of original designs, many of which are drawn and etched with a degree of accuracy, spirit, and effect, which it would be even now difficult to surpass.* Ray's *Systematic*

* Among these, the reader may refer to tab. E. 2. F. i. 3, 4, 5, 6, &c. The holibut (*fig.* 6.), is uncommonly fine, and the flatness of the sole (F. *fig.* 7.) is inimitably expressed.

Synopsis appeared only in 1713, and contains little that can be said to have advanced the science.

(57.) But ichthyology was now to assume a form and order which it had never yet appeared in; for, in the year 1738, the works of the great Artedi, the friend and disciple of Linnæus, were given to the world by his no less celebrated master, whose arrangement of the fishes in the *Systema Naturæ*, no doubt, laid the foundation of that by his scholar. Having already, in a former volume, expressed our sentiments on the general system of Linnæus, we may at once pass to that of Artedi, whose knowledge of fishes, and whose views on their natural classification, are undoubtedly much more profound and correct than those exhibited in the *Systema Naturæ*. Artedi, in short, must be considered the true founder of systematic ichthyology: he has treated the subject both as a philosopher and a naturalist; and we presume to think he deserves much higher honour than some writers of the present day have been disposed to give him. It is not a little remarkable, and may be urged as a proof how truly he deserves this praise, that three out of his five primary divisions have been adopted by M. Cuvier; of the other two, one (*Plagiuri*) is composed of the cetaceous *Mammalia*, and the other of the *Plectognathis* (Cuv.). True it is that Artedi, like all the naturalists of that time, was not aware of this latter order possessing branchial rays, and consequently named them *Branchiostagi;* nevertheless, it is quite clear that Artedi perceived they formed a natural group, however he erred in part of their definition, for he united with them the genus *Lophius* and *Syngnathus*, the whole of which, as will hereafter appear, possess all the characters of a primary order. We must leave this subject, however, which more properly belongs to another part of our volume, and turn to another labourer in the same vineyard, although in a different department. We allude to Klein, whose valuable labours on the anatomy of fishes first opened the view of a new and untrodden field to future ichthyologists, and laid the foundation of

all that has since been accomplished. Klein was a most industrious and even voluminous writer; and though but little can be said of his ornithological writings, those which relate to the class before us place him, in our estimation, among the most eminent writers in this department of zoology. His chief work is now become so very scarce*, that we have never seen a complete copy offered for sale; while the numerous figures it contains, although perhaps not equal to those of the present day, will always render the work a standing authority.

No publication of moment appeared during the next fourteen years, excepting that of Gronovius, whose name still ranks high both in botany and zoology. Of his writings we have already spoken.† His latest work on ichthyology, the only one we possess‡, is still of much value, not only from containing the characters of several genera first defined by this author, but also for the excellency of the plates; nearly all the figures, indeed, are admirable, and most of them, in the artistical spirit of their execution, are equal to the very best of the present age. The next author of any considerable note was Gouan§, whose ichthyological labours were confined to one volume, in which the genera are described with all that attention to detail, and in that technical language, introduced by Linnæus with such incalculable advantage to science.

(58.) Hitherto, however, ichthyology had been entirely without any work expressly devoted to coloured representations of fishes: the magnificent volumes of Catesby, indeed, on the natural history of Carolina, contained several figures of this class of animals; yet it

* Jacobe Theodore Klein, Historia Piscium Naturalis, promovendæ missus, 1—5. Gedani, 1740—1749. The first part contains six plates; the second, four; the third, seven; the fourth, sixteen; the fifth, twenty; besides a portrait of the author. ——, Mantissa Ichthyologica de Sono et Auditu Piscium. Lips. 1746. In my copy of this volume the following note is inserted: — "This is one of the scarcest modern books of its kind that I know of; I desired Dr. Schœffler, of Dantzig, to procure me a copy, but there was not one to be had in 1772. — A. Y. B."

† Preliminary Discourse, p. 43.

‡ L. T. Gronovius, Zoophylacii Gronoviani, fascic. I. Lugduni Batavorum, 1763, folio, with thirteen plates of fish.

§ Ant. Gouan, Historia Piscium. Strasb. 1770. 1 vol. 4to.

was not until the year 1785 that the first work of this sort, expressly devoted to fishes, was commenced by the celebrated Bloch. He was a Jewish physician settled in Berlin; and his ichthyology, in twelve folio parts, contains no less than 452 coloured plates: of these, 216 belong to the first six parts, and comprise nearly all the European fish; the other six, more especially devoted to the exotic tribes, are now very rare, in consequence of a fire having destroyed the greater portion of the copies. The figures, however recognisable, in most instances are very inaccurate both in their drawing and colouring, particularly those in the latter volumes; so that they fall short, in every respect, to those of Gronovius and the original plates of Willughby: nevertheless, Bloch must always be classed among the highest ichthyologists: his descriptions are generally very good, and he refrained from incorporating in his work a great number of species loosely described. and still worse figured, in former publications. This judicious plan, however, was not followed by Schneider, his commentator and continuator, who published two additional volumes with 110 plates, so late as the year 1801.* The admirable volume on the anatomy of fish, by Dr. Munro, was also published in 1785.† It is gratifying to our national character that the labours of our distinguished countryman should thus have laid the most permanent foundation for all that has been subsequently achieved in this department. The great work on the natural history of fish, by the count Lacepede ‡, was the next publication after that of Bloch upon general Ichthyology. As it embraced an account of all recorded species, whether examined by the author himself or known only from the descriptions of others, it became, in some degree, a compilation, as all general systems so constructed must be; when, therefore, we make allowance for this, and for the very little attention that was then paid to cha-

* Schneider, Systema Ichthyologia. Berlin, 2 vols. 8vo. 1801.

† This is omitted by some oversight in the lists of the Règne Animal.

‡ Lacepede, Comte de, Hist. Nat. générale et particulière des Poissons. Paris, 5 vols. 4to. 1798—1803.

racters now found to be of much importance, we must pronounce this the most valuable ichthyological system that had then appeared. It is not, like others in different branches of zoology, a servile copy of the Linnæan divisions, but numerous others are defined for the first time: and when we look back to what systematic ichthyology was before, and what it became by the labours of Lacepede, no one can in fairness deny but that a great and important advance in this science had been effected. No naturalist can hope to achieve more than this, however great may be his abilities; and we do not, therefore, understand upon what ground so much censure has recently been cast upon the works of this distinguished Frenchman by some of his own countrymen. Lacepede's generic names, indeed, are destitute of euphony; but this is secondary, and can easily be remedied; and numerous errors may, no doubt, be found in such a vast undertaking: but we contend again, that these errors were inevitable, and resulted more from the paucity of his materials, and the inaccuracy of those who had gone before him, than from any deficiency in his powers of discrimination. Such errors might be pardoned half a century ago, but are totally inexcusable in the present day. Certain it is, however, that Lacepede's *Ichthyology* will always be a standard authority, even for his supposed errors; and it will be found by those who have occasion to consult them, that he is by no means chargeable with several that have been of late attributed to him. The figures, on the other hand, although well engraved, are, in general, very deficient in accuracy; the major part being either copies, or drawn by artists who were totally ignorant of the scientific details of their subject. It is certain, however, that the work had a great and almost immediate effect in awakening attention to this long neglected branch of zoology. The interval between the respective works of Bloch and Lacepede comprised a period of near twelve years, in which, with the exception of a number of valuable anatomical dissertations, nothing of material

importance on the general subject had appeared. We here except the compilation of Gmelin, which, however useful it might have been in regard to species, cannot be said to have permanently advanced the science. But no sooner had the great reformations effected by Lacepede become generally diffused, by reprints and translations, than ichthyology received a new impetus; whether this, however, was the true cause, or whether, about this time, zoology in general began to be more studied, certain it is that it advanced more rapidly. The clear and compendious tables of M. Dumeril*, which incorporated the new divisions of Lacepede, placed all the modern improvements of artificial classification in the hands of students; and although the naturalists of Britain still adhered to the Linnæan system, that of Lacepede was generally adopted on the Continent. A most valuable addition to our knowledge of the fishes of India was made in 1803 by Dr. Russell; the descriptions are excellent, and the figures, although in outline, and executed by Indian artists, sufficiently good for scientific purposes.

(59.) The year 1810 was remarkable in the annals of our science for the appearance of two important works on the ichthyology of the Mediterranean: one was by M. Rafinesque Schmaltz, subsequently professor of natural history in Lexington, U. S.; the other, relative chiefly to the fishes of Nice, was from the pen of M. Risso. The first of these is of much importance; and, from particular circumstances, will claim more of our attention than would at first appear necessary. M. Rafinesque's Sicilian works are now become so very scarce (the greater part of the unsold copies having been lost at sea), that few naturalists will have the power of consulting them. His chief ichthyological work is a synopsis of "New Genera and Species of Animals and Plants" found by the author in Sicily; and this was followed by a pamphlet, entitled "Indice d'Ittiologia Siciliana." The details of the new views of M. Rafinesque, in regard to classifica-

* Dumeril, Zoologie Analytique, 1 vol. 8vo. Paris, 1806.

tion, are too long to be inserted in this volume, but they will be occasionally adverted to. The faults that have been dwelt upon* in these two works are such as all authors, even M. Cuvier himself, is not exempt from; they seem to us, in short, too trivial for the notice of the historian, and too general to be affixed to any one author in particular. We freely admit that M. Rafinesque (then living, as we were, in a remote part of Europe, cut off, by the late war, from all intercourse with the Continent) was not well informed upon the current and almost daily discoveries going on there; and that some few of his species then supposed new, were really not so: but who is exempt from such errors, if errors they are? or how are such coincidents to be prevented, when naturalists, in distant places, and unknown to each other, are working at the same time upon the same subject? On the other hand, it must not be concealed that M. Rafinesque anticipated, by nearly ten years, a very large proportion of the generic and sub-generic distinctions subsequently taken up in the *Règne Animal*, in the first edition of which it is clear that its learned author was totally unacquainted with the works above mentioned, or that he was unconsciously repeating, under new names, a considerable number of the genera and sub-genera

* M. Cuvier observes: "He has, besides, entered in his catalogue, without examination, all the species given by Lacepede and Linnæus as belonging to the Mediterranean, which has caused him to reckon several which are purely imaginary; and this extends even to his genera: thus, his *Aodon*, taken from Lacepede, is the *Raie cephaloptère*; his *Macroramphus*, taken from the same source, is the *Centriscus*. He has greatly multiplied the genera, and sometimes on slight grounds; so that, without reckoning those which are not inhabitants of the Mediterranean, there are 139; and yet, notwithstanding his readiness to make these divisions, he has not done so in circumstances in which it would be imperatively commanded by the laws of classification. He leaves, for instance, the anchovy in the herring genus, and the plaice in that of the sole; while of the single Linnæan genus of *Squalus* he has made sixteen." "These two works are, nevertheless," continues M. Cuvier, "very worthy of attention, on account of some original ideas, and of descriptions and figures of the fishes themselves, which are to be found nowhere else. The author, also, has paid attention to the Sicilian names of most of his species." If Rafinesque made too many genera, M. Cuvier has nearly doubled them; and as for the "laws of classification," which imperatively command the formation of these genera of M. Cuvier, the term is totally misapplied. Genera, like those of Rafinesque and Cuvier, are mere matters of individual opinion, because they are made without any ulterior reference, and are merely divisions, with which no laws of artificial classification have any thing to do.

long before established in the volumes of professor Rafinesque. It would have been well had these unintentional errors been rectified in the second edition, or in the general ichthyological work of MM. Cuvier and Valenciennes; but they are not so; and naturalists will judge how far this is consonant with common justice, or with that law of priority which is the only safeguard to the reputation we all covet. The generic characters of Rafinesque are as simple and intelligible as those of Linnæus, and the derivation of their names strictly classical and euphonious. In regard to the majority of those species which have been termed "imaginary," or inaccurately described, our firm conviction is, that nearly all, eventually, will be as fully established as those of the best known in our systems. We have formed this opinion not from theory, but from actual observation, and from having verified, in many instances, the validity of Rafinesque's characters.* The truth is, that

* In further justification of the opinions here advanced, it may be proper for me to state that I had the pleasure of M. Rafinesque's society, during the three years of my official residence in Sicily, from 1807 to 1810, and again in 1812, when we were both at Palermo, prosecuting our botanical and ichthyological researches together. Circumstances have hitherto prevented me from giving them to the public; but an extensive series of drawings and descriptions, made from the life, of the Sicilian fishes, not only confirms the accuracy of M. Rafinesque, in many instances where he has been charged with error, but affords strong grounds for believing that one half of the Sicilian species, said to be found also in the Atlantic Ocean, Britain, &c., are, in reality, quite distinct. M. Rafinesque, unfortunately, was unable to publish more than a synopsis of his ichthyological discoveries; and his figures, being very slight, are often not calculated to clear up those doubts which the brevity of his descriptions sometimes creates: nevertheless, to one who examines the species on the spot, in a *fresh* state, there are few which may not be identified. M. Cuvier often asserts that all M. Rafinesque's species were described from preserved specimens: but this is an error — they were all taken from the life. We both used to frequent the fish-markets, and we procured all our specimens there, or from fishermen who were in our employ. I was frequently urgent with my friend to preserve, at least, such as were the most remarkable of his new genera, anticipating the incredulity that has since been attached to them; but this advice, unfortunately, he never adopted. The greater part of those which I examined, after being drawn and described, were thrown away or eaten; a military life not being suited to the formation of such collections: but many of those species met with near Palermo, were preserved in spirits, and sent to the British and Zoological Museums; few, however, of these are now in existence. One cause, perhaps, of the errors of M. Cuvier regarding the Mediterranean fishes, may be, that he had only examined preserved specimens, either distorted by stuffing, or bleached and shrivelled by alcohol, so that it becomes often difficult to recognise the most common species. If I have dwelt too long upon this subject, I hope the benevolent and candid reader will excuse me: it has originated in my desire to do adequate, though tardy, justice to one whose

Sicily is perhaps the richest field for the ichthyologist, of any yet explored in the Mediterranean, in whose warm and prolific waters, washing the tranquil shores of so many islands, an immense variety of fish are constantly found. Besides these two works, more especially devoted to the ichthyology of Sicily, many other papers by the same author are scattered in the periodical publications of Palermo; and he has also given a most original and valuable account of the fishes of the great river Ohio. The second volume on Mediterranean Ichthyology, by M. Risso, just alluded to, is highly interesting, from an account of several new species, and a few new genera; but the classification is that of Lacepede, and the figures too small to be serviceable: a second edition, as we find, was subsequently published; but this we have not yet seen. The fish of these shores were subsequently illustrated, in detached portions and separate essays, by several learned foreigners, among whom the names of Viviani, Spinola, and Valenciennes, are conspicuous; while the labours of Leach and Montagu, in our own country, have been justly praised. A most perfect and masterly account of the singular fishes of Egypt has proceeded from the accomplished pens of the illustrious Geoffroy Saint-Hilaire, and his talented son Dr. Isidore Geoffroy; the figures are drawn from the life by the younger Redouté, but they are by no means good: the expense of this valuable work renders it inaccessible to the generality of purchasers. A decade of Cuban fish, very fully and perfectly described, came from the pen of M. Desmarest; but the plates by which it was intended to be illustrated, we have never seen. The ichthyology

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whole life has been devoted to science, and who has been singularly unfortunate in his worldly concerns; who, notwithstanding his eccentricities, has a kind and benevolent heart; and whose labours have never been appreciated as I think they deserve. But for this, M. Rafinesque would not, in advancing life, have to contend with pecuniary difficulties, from which a small pension from the American government, proverbially generous to her scientific sons, would set him free.

of America, about this time, began to excite the zealous attention of several of our transatlantic brethren; and the various essays and papers by Dr. Mitchell, Le Sueur*, Harwood, and Rafinesque, have accumulated such valuable materials, that we trust they may be soon augmented, and condensed into a general work devoted to this branch of American zoology.

(60.) But we must not depart from the chronological order of our rapid survey. The year 1817 saw the publication of the first edition of the "Règne Animal,"—a work replete with profound anatomical science, and with many just and admirable improvements in scientific arrangement. Having already spoken so fully of these celebrated volumes, on a former occasion, we have only to look to its ichthyological portion. Besides the genera that had previously been named and defined by Rafinesque, but unknown, and therefore unacknowledged by M. Cuvier, there are a great number of others really new; and the whole, being well digested, give us the most finished and popular system that had appeared since the days of Lacepede. It must not be supposed, however, as some have imagined, that there was any thing sudden or astonishing in the advance which was thus made. Ichthyology, like all other branches of natural history, and, indeed, all other sciences, had been advancing gradually and progressively. Since the decline of the Linnæan school, the first, and therefore the most signal, reformation in the genera was undoubtedly effected by Lacepede: the new groups pointed out by Rafinesque, materially advanced this

* It is scarcely possible to praise too highly the delicate and masterly delineations which so peculiarly characterise every subject which comes from the pencil or the graver of Le Sueur, whom I have ever looked upon as the first zoological artist of the age. His are the only delineations I have seen, where the delicacy, the accuracy, and the high finish of the French school are united with the freedom, grace, and decision of the English style: the ease and ingenuity with which he can comprise large subjects within a small compass, without the least confusion of the parts, is seen in many of the exquisite outline plates, drawn and etched by himself, in the early volumes of the American Transactions. Science and the fine arts must ever deplore that the noble work on the *Medusæ*, long contemplated by this prince of zoological painters, has never been given to the world. Surely a sufficient number of subscribers might be found to protect the author from pecuniary loss?

reform; and M. Cuvier's system, again, aided by his high reputation and anatomical skill, made another signal yet graduated advance towards a knowledge of the true structure of this difficult class. Like all other new systems, however, it was some time before this received favour or adoption, at least in this country; and such will ever be the case when old ideas are to be cast aside, new ones learned, and prejudices overcome. The truth is, that no favour or support can be expected to new views from old naturalists: we do not like to have our long-cherished creeds disturbed; and without, perhaps, being aware of it, we naturally, and almost inevitably, become strongly prejudiced in favour of what is old and established. It is, therefore, not so much to the existing as to the succeeding generation that we must look for a candid and impartial judgment upon those innovations, and which are in direct opposition to high authorities and long-cherished views. And this, perhaps, is for the best. Throughout nature, that which is most permanent is of the slowest growth: the oak is only in its vigour, when the surrounding plantations of poplars and larches are withering into decay.

(61.) Additions to ichthyological science now became so numerous, that we must altogether confine our notices to such as are of leading importance. In this view we must regard the most valuable account now extant of the fishes of India, more especially those of the Ganges, by Dr. Buchanan Hamilton. The descriptions, which are clear and ample, are interspersed with many original and interesting observations on affinities and natural groups; while the figures, much superior to those of Russell, are very neatly executed. A vast number of new species are here first described. We have no hesitation in considering this work as the most original and valuable that this country has yet produced; and it places its author, now dead, in the foremost ranks of this science. The different artificial systems of MM. Blainville, Risso, Pallas, Goldfuss, and several others, need not here be mentioned; they are not founded upon any ge-

neral considerations, drawn from other classes of the animal kingdom; and although each makes, in some of the details, a greater or lesser approach to nature, each may be also said to have its weak points. Neither have we space to particularise, in detail, the valuable additions made to the comparative anatomy, or rather the internal structure, of fish, by many able and skilful men, who now began to take up this department of the science; most of these essays are in the voluminous and expensive *Transactions* of societies, and are therefore not very accessible to the student. This latter obstacle, unfortunately, is also an impediment to the possession of the numerous and beautiful figures of fish dispersed in the *Zoological Atlases* of the French circumnavigators, and described by the naturalists who accompanied the different expeditions: many interesting fish are also figured among the plates taken from the late general Hardwicke's Indian drawings, edited by Mr. J. E. Gray; and the volume on those discovered by Dr. Richardson forms a valuable addition to our knowledge of the Arctic species.

(62.) There are two important works, however, which deserve a more particular notice: one of these includes the numerous and beautiful species discovered by that enterprising traveller and accomplished zoologist, Dr. Rüppell, on the shores of the Red Sea.* Although, from being drawn on stone, the execution of some of the figures appears to be coarse, yet they are the most masterly and artistical (next to those of Le Sueur) that we have ever seen: they wear every appearance of having been drawn and coloured from the fresh subjects with evident care and exactitude; so that they deserve to be ranked among the most valuable that have ever been published: the descriptions are in German, but the specific characters are also in Latin. We anxiously look forward to this unrivalled collection of coloured figures being augmented, and in the same style, by those new species discovered during the second expedition of this zealous

* Atlas zu der Reise im Nordlichen Afrika, von Eduard Rüppell — Fische des Rothen Meers. Frankfurt am Maine, 1828, folio, with 35 plates.

naturalist to the same regions.* The other work we allude to is on the fishes of Brazil, discovered by the late Dr. Spix, and edited by one of the most accomplished of living ichthyologists, M. Agassiz: the figures seem to be accurate†, and are highly finished, — too much so, indeed, since this circumstance renders the work very expensive; while the letterpress is particularly ample and elaborate: several plates are devoted to pictorial representations of the modes of fishing pursued by the native tribes; and others, to the delineation of the different form of the scales in various species, a subject upon which M. Agassiz is known to have bestowed great attention. It is to be regretted that so very few of the discoveries, not merely of new species, but of singular and hitherto unknown types, contained in the works just mentioned, should have been incorporated in the second edition of the *Règne Animal*, of which the ichthyological volume appeared so late as the year 1829. M. Cuvier, indeed, has here characterised several additional genera, not contained in the first edition; but they are chiefly, if not entirely, the fruits of his own observation. These additions, however, form but a small proportion of the discoveries effected in this science since 1817; so that the last work must be looked upon more as the result of the learned author's individual researches, than as giving a general exposition of the present state of ichthyological knowledge. As a collection of important facts, and of anatomical investigations, it excels all others; and whatever objections may be raised to the formation of the groups, there can be but one opinion of its being of great usefulness. The extensive researches of the author are more conspicuous in the great work commenced by him in conjunction with M. Valenciennes; and this will ever remain an

* Since the above was written, Dr. Rüppell has kindly forwarded us a copy of his Second Atlas, entitled "Neue Wirbelthiere zu der Fauna Abyssinien gerörig, &c." The fish form one vol. folio, with 33 plates, more delicately but less vigorously delineated than the other.

† Although the majority are deficient in grace, and what is called good drawing, the minute details of the teeth, &c. are particularly well done.

honourable monument of their joint labours. The descriptions are generally ample, and the plates are delicately and, for the most part, correctly executed: we sincerely trust that this valuable work has received no check in its publication. It is now near twelve months since the last or twelfth volume was published; and nearly as many more will be necessary to complete it on the same plan. Such a work, as a general history of fish, is the most perfect yet contemplated; and no library, whether public or private, can be called well selected, without these volumes. Having said thus much, our further observations will be offered under the head of those groups to which they are more especially applicable. Before concluding this hasty sketch, we cannot omit to mention the valuable addition made to our native ichthyology, by the two volumes upon British fishes, by Mr. Yarrell*; they form a most important acquisition to the British naturalist; and they doubtless will be the means of eliciting, in a few years, a vast mass of new information on these animals. Notwithstanding the numerous additions thus made to our marine fauna, the perusal of these volumes has convinced us, that many species require further investigation. The recent discovery of that extraordinary fish by Mr. Couch, our well known Cornish ichthyologist, which has been named *Amphioxus lanceolatus* by Mr. Yarrell, seems to justify our anticipation of the novelties yet to be found on the British coast. We have seen the prospectus of a general work on the fluviatile fish of Europe, with coloured plates, projected by M. Agazziz, but we know not whether its publication has commenced.

(63.) A few remarks on the PRESERVATION OF FISH will probably be useful to many of our readers, particularly in a volume which is intended as a compendium and text book for the ichthyological student. Unfortunately for our museums, no method has yet been discovered by which the rich and vivid colouring,

* William Yarrell, V.P.Z.S., F.L.S., A History of British Fishes, illustrated by nearly 400 wood-cuts. 2 vols. 8vo. London, 1836.

so often seen in these creatures when fresh, can be preserved. Hence it is that so few collectors possess them; for as there is nothing pleasing to the eye in the discoloured body of a fish immersed in spirits, they will only be preserved as objects of curiosity, or for purely scientific purposes. There are two processes by which this object may be accomplished: the one, by drying the specimen; the other, by immersing it in alcohol.

(64.) Large fish, having tough skins, as the sharks, and others covered with bony plates or spines, like the cheloniform genera, are best preserved in a dry state. For this purpose, the most simple method is to make a longitudinal cut from the throat to the vent, sufficiently long to admit the whole of the flesh and bones to be removed; or, when practicable, to allow the fish to be skinned, leaving the bones of the head entire: the inside surface may then be anointed with the arsenical soap; and after being filled with sand to its natural dimensions, and gradually dried, the skin retains its form: a portion of the sand may then be removed, to render the specimen lighter, and the cavity filled with cotton. The incision, of course, must be sewed up in the first instance; but if the specimen is re-opened to substitute any softer material for sand, it can be again sewed up, as the original holes remain. The cheloniform fishes, being small, will not require skinning; and their mailed plates being hard and compact, the form will be retained even without any stuffing.

(65.) The most useful, as well as the most simple, method, however, is to preserve all such fish as are of a moderate size, in spirits. Wide-mouthed bottles with ground glass stoppers, such as are seen in apothecaries' shops, are the best vessels for this purpose: but when these cannot be procured, old pickle bottles, of green glass, will do very well: these can generally be procured abroad and at home; and, if well corked, and the top afterwards covered with bladder, they will travel, with ordinary care, over the world. The great object

is to render them, if possible, air-tight, to prevent the evaporation of the spirits. The best liquor, perhaps, that can be used, is spirits of wine; but this is very expensive, and cannot always be procured. We believe, however, that the common rum of the West Indies is equally efficacious; and, indeed, *pure* spirits of any sort will answer the same purpose; but Mr. Yarrell confirms what we have also experienced, that the common English gin, as sold in the shops, is so much adulterated, that it is quite unfit for this purpose; so that its only qualities seem those of destroying living men and dead animals. Next, in regard to the specimens, they should not be so much crowded as to press upon or against each other, so as to cause injury; it would even be adviseable, where many are put into one bottle, that a little cotton or tow be inserted between them; or each may be wrapped in cotton, or even sewed up in a thin calico bag, before being put in the spirit. Where it is intended to form a large collection for transmission to Europe, and glass bottles are not to be procured, a small keg may be used as a substitute; and one end should be left open until a sufficient number of specimens are procured to fill it: these may be placed in layers, alternately, with a thin one of cotton or tow, and the spirit progressively added, as the filling goes on, taking care that no greater quantity of the liquor is put in at one time than is sufficient just to cover the specimens; by this precaution they will be preserved compact, the liquor will have time to insinuate itself into the bodies, and the replenishing can proceed gradually. When the cask is full, the head is to be again fixed, and the sutures secured outside by pitch, to prevent leakage.

(66.) When any particular notes are made as to the colours, habits, or other peculiarities, the most effectual method of identifying the specimens is, by attaching to them a small label of thin lead, whereon is stamped a number, agreeing with that of the catalogue. This will supersede all necessity for taking notes on the structure, or of such particulars as can be seen in the

preserved specimens. As the colours, however, are entirely changed by the action of the spirits, notes upon each, when practicable, should always be made. To those collectors, however, who are draftsmen, we should recommend the plan pursued by us abroad. A rough sketch was made from the fish, and all the tints washed in, to enable any one to make an accurately finished drawing afterwards, provided he possessed the specimen itself, and the finished outline.

(67.) The readiest way of procuring specimens, to a person not himself a fisherman, but residing in a maritime town, is by regularly frequenting the fish markets, where nearly all the edible species found upon the neighbouring coast will, at one season or other, be exposed for sale. Particular people, however, have their local prejudices in regard to such as are considered not wholesome; for these the collector should inquire of the fishermen themselves; or, what is much better, let him go in their boats, and be present at the drawing up of their nets: numerous species too small for the market, or not usually eaten, will thus be procured. Both these plans we pursued, with the greatest success, at Palermo, Messina, Pernambuco, Bahia, &c.

(68.) In regard to the localities most likely to produce abundance of species, it may be stated, almost as a general rule, that the coasts of islands, widely separated from continents, are the most productive: hence it is that the tropical archipelagos of the East and West Indies are much richer in fish than the coasts of the neighbouring continents; and to this, also, we attribute, in a great degree, the peculiar abundance, both in number and variety, found along the coasts of Sicily and Malta. The Grecian islands, no doubt, are equally abundant; yet they have never been explored. But of all the islands bordering the European geographical range, we apprehend none offer such a splendid field for the researches of the ichthyologist as the Madeira islands on one hand, and the Azores on the other; the latter, more especially, may be called an unexplored pre-

serve for new discoveries. Situated at such a long distance from any continent, this cluster of islands must be a central rallying point for innumerable species during the breeding season, and to which they make their way from every point of the compass.*

CHAP. IV.

ON THE SYSTEMATIC ARRANGEMENT OF FISHES.

(69.) On a former occasion we have explained and fully discussed the nature of those various arrangements, methods, or systems†, which are used by naturalists for making known the objects of their study; but as the former volumes may not be in the hands of all who possess this, and as it is desirable that each, as far as possible, should be complete in itself, we deem it advisable, before entering into the details of this chapter, briefly to recapitulate some of the most important considerations on this subject,—the more so, as much of novelty will be found in our views of the natural arrangement of this class, and it may justly be expected from us to state the grounds upon which we venture to bring forward an entirely new arrangement.

(70.) There are two modes by which the various classes of natural objects may be arranged: one is to view each class or division as isolated, and to construct a system upon principles applicable to them, and to them *only*; the other is to view them only as parts of one vast whole, and to construct our arrangement of them

* We have long had an ardent wish to investigate either Madeira, or the Western Islands,—the latter a bright, although neglected, cluster of jewels in the diadem of the young and lovely queen of Portugal; and we take this opportunity of soliciting information from such of our readers as may be living there, or have the means of rendering a six months' residence at some one of these islands agreeable in point of society, and beneficial to our scientific pursuits.

† Geography and Classification of Animals, p. 122.

upon principles that are not merely applicable to them, but to all other portions of the animal or vegetable creation. Now, if the simple question were put to any reflecting mind, which of these plans was the most philosophical, or the most likely to exhibit the true series of nature, no one would hesitate to decide upon the last. This is only a different method of stating the true nature of artificial and of natural systems. The former, indeed, cannot be said to be founded on any *general* or fixed principles, extending their influence to other branches of zoological science; for although, in one sense, each class may be arranged on a principle, yet that principle is altogether arbitrary. There may be principles of ichthyology, of ornithology, and of all the other classes, but there cannot be principles of zoology, unless the whole of its divisions present a consistent uniform harmony in their arrangement. Upon this vantage ground, therefore, the philosophic naturalist takes his stand; and while he willingly confesses the advantages, nay, the absolute necessity, of availing himself of the artificial mode of arrangement in little known groups, he feels fully persuaded that the very first imperfect glimpse of the natural system should be seized and adopted, since its very errors will eventually lead to truth, and accelerate the discovery of those principles upon which alone zoology can be rendered a science of demonstration, at least in the opinion of those who have given laws for the prosecution of the physical sciences, of which zoology, vast as it is, forms but a small part.

(71.) One of the consequences involved in the law of representation (or that by which one group of animals represents another group in a totally different class) is, that the primary divisions of a class are no longer arbitrary. We advert to this subject more particularly in the present volume, because, although we have adopted, in almost every instance, the higher groups pointed out by our predecessors, we have not given to them that rank in the class which some have

assigned to them. We have already shown, in former volumes, that the primary groups of birds represent those of quadrupeds; and it therefore follows, that if we can find certain groups of fish which represent both these, we arrive, by induction, to the sure conviction that such groups of fish constitute the primary divisions of the class. The *Plectognathes*, for instance, are placed by M. Cuvier as a part of the osseous fishes, when, even by his own admission, their skeleton is semi-cartilaginous. The group, however, is evidently natural; and we accordingly preserve it, giving it only a higher rank. But this change, however, is not the result of arbitrary opinion: neither is it because the great fathers of ichthyology did the same; for they also were guided in their decision, not by principle, but opinion. It is because these fishes, besides the peculiarity of their skeleton, unquestionably represent one of the grand divisions of the *Vertebrata*, as well as one of the primary orders of quadrupeds, of birds, and of reptiles: and as there is no other division of fishes which does the same, the *Plectognathes* are thus proved to be one of the chief divisions of the class. The same remark is applicable to the apodal fishes of authors, where we find all the species destitute of ventral fins; but the skeleton is variable. Why, then, is this an order? The question is thus answered: Cuvier has shown they are closely connected, and, in fact, pass into the osseous fishes; and he also coincides in the opinion of all our best zoologists, that they likewise make an equally close approximation to the *Vermes*, or worms. Now these apparently opposite relations could not well be true, if some of the eels had not the bony skeleton of the more perfect tribes, while in others it was rudimentary, in order to mark their proximity to the *Vermes*. The skeleton is consequently variable; but in all other respects the characters of the apodal fishes are constant.

(72.) Preserving the distinction between artificial and natural systems elsewhere explained*, we shall at

* Geography and Classification of Animals, p. 125.

once proceed to the enumeration of those which have been the most celebrated; but the curious reader will find several others in the elaborate history of ichthyology drawn up by MM. Cuvier and Valenciennes. We shall confine ourselves, on the present occasion, to those of Artedi, Linnæus, Cuvier and Valenciennes, Bonaparte, and Oken.

(73.) One of the primary divisions in the system of ARTEDI (1738), as before mentioned, is composed of the *Cetæ*, or aquatic *Mammalia*. The other four are characterised as follows:—

Tail perpendicular, fins supported by rays.

Skeleton bony.	With bony branchia.	Fins with soft rays.	MALACOPTERYGII.
		Fins with spined rays.	ACANTHOPTERYGII.
	Branchia destitute of bones.		BRANCHIOSTEGI.
Skeleton cartilaginous.			CHONDROPTERYGII.

The first order, or the *Malacopterygii*, are arranged in six divisions, according to the number and position of the dorsal fin; while the *Acanthopterygii* are merely divided into those having the head smooth or rough. The genera are as follows:—

ORDER I. — MALACOPTERYGII.

Syngnathus.	Osmerus.	Stromateus.
Cobites.	Salmo.	Gadus.
Cyprinus.	Esox.	Anarhichas.
Clupea.	Echeneis.	Muræna.
Argentina.	Coryphæna.	Ophidion.
Exocœtus.	Amodytes.	Anableps.
Coregonus.	Pleuronectes.	Gymnotus.

ORDER II. — ACANTHOPTERYGII.

Blennius.	Sparus.	Scorpæna.
Gobius.	Sciæna.	Cottus.
Xiphias.	Perca.	Zeus.
Scomber.	Trachinus.	Chætodon.
Mugil.	Trigla.	Gasterosteus.
Labrus.		

ORDER III. — BRANCHIOSTEGI.

Balistes.	Cyclopterus.	Lophius.
Ostracion.		

ORDER IV. — CHONDROPTERYGII.

Petromyzon.	To these are added in an	*ræna, Hepatus, Capriscus, Tænia, Pholis, Citharus, Atherina, Liparis,* and *Chelon.*
Acipenser.	Appendix the genera	
Squalus.	*Silurus, Lepturus,*	
Raia.	*Phycis, Cicla, Sphy-*	

(74.) The arrangement of LINNÆUS, as given in the twelfth edition of the *Systema Naturæ*, differs but little from that of Artedi. As an artificial system, it is on a more simple plan than that of any other. We shall give the reader, by the following table, a much better idea of the system of the great Swede than by any other means; and we shall then offer a few observations on the general nature of the groups. The whole are distributed into six orders, founded either on the position of the ventral fins, or, what is much better, on the structure of the gills. The orders are named, I. *Apodal;* II. *Jugular;* III. *Thoracic;* IV. *Abdominal;* V. *Branchiostegious;* and VI. *Chondropterigious:* the contents of each being as follows:—

I. APODAL. *Ventral fins none.*

1. Muræna.
2. Gymnotus.
3. Gymnothorax.
4. Trichiurus.
5. Anarhichas.
6. Ammodytes.
7. Ophidium.
8. Stomateus.
9. Xiphias.
10. Sternoptyx.
11. Leptocephalus.

II. JUGULAR. *Gills bony, ventral fins placed before the pectoral.*

12. Callionymus.
13. Uranoscopus.
14. Trachinus.
15. Gadus.
16. Blennius.

III. THORACIC. *Gills bony, ventral fins placed directly under the thorax.*

17. Cepola.
18. Echineis.
19. Coryphæa.
20. Gobius.
21. Cottus.
22. Scorpæna.
23. Zeus.
24. Pleuronectes.
25. Chætodon.
26. Sparus.
27. Labrus.
28. Sciæna.
29. Perca.
30. Gasterosteus.
31. Scomber.
32. Mullus.
33. Trigla.

IV. ABDOMINAL. *Gills bony, ventral fins placed on the belly behind the thorax.*

34. Cobites.
35. Amia.
36. Silurus.
37. Teuthis.
38. Loricaria.
39. Salmo.
40. Fistularia.
41. Esox.
42. Elops.
43. Argentina.
44. Atherina.
45. Mugil.
46. Mormyrus.
47. Exocœtus.
48. Polynemus.
49. Clupea.
50. Cyprinus.

V. BRANCHIOSTEGIOUS. *Gills without bones.*

51. Ostracion.
52. Tetrodon.
53. Diodon.
54. Syngnathus.
55. Pegasus.
56. Centriscus.
57. Balistes.
58. Cyclopterus.
59. Lophius.

VI. CHONDROPTERIGIOUS. *Gills and bones cartilaginous.*

60. Acipenser.	62. Squalus.	64. Petromyzon.
61. Chimæra.	63. Raia.	

The above arrangement is so far natural, that it preserves in a distinct group all the cheloniform fishes (*Plectognathes,* Cuv.) whose body is encased in a coat of mail, or covered with hexagonal scales, and which more especially differ from true fish in having the branchia concealed and the operculum fixed. This, which we have shown to form a primary group, is placed next to the chondropterigious order, where the skeleton becomes entirely cartilaginous. The apodal order, had it been restricted to the eel-like fishes, would have corresponded in its contents to ours; but there seems no reason whatever for placing the sword-fish (*Xiphias*) next to *Ophidium,* or *Leptocephalus* next to *Sternoptyx.* The three next orders, of *Jugular, Thoracic,* and *Abdominal,* are excellent as artificial groups, enabling the student, by attention to the single circumstance of the position of the ventral fins, to ascertain the nomenclature of his specimens.

(75.) The system of CUVIER, and of his able coadjutor VALENCIENNES, will now be more particularly detailed, as given in the last edition of the *Règne Animal.* The primary divisions are two:—the first composed of what are called true or osseous fishes, having the bones solid; the second are the *Chondropterygii,* or cartilaginous fishes. In these latter the bones of the lower jaw are supplied by those of the palate.

(76.) OSSEOUS, or TRUE FISHES, are divided by our author, in the first instance, into two most unequal assemblages:—1. Those in which the gills, or branchia, are pectinated; and, 2. those in which they resemble a series of small tufts. All true fishes come under the first of these divisions, excepting the genera *Syngnathus* and *Pegasus* of Linnæus, which constitute M. Cuvier's order *Lophobranchii.* The first division of osseous fishes is again divided into two groups of equal dis-

parity: the one containing the *Plectognathes*, or our cheloniform fishes, answering to the *Branchiostegi* of Artedi; these having the maxillary bone and the palatine arch fixed to the cranium: the whole of the remainder, or the vast multitude of ordinary fishes wherein the upper jaw is not fixed, form the osseous division. In this latter, observes M. Cuvier, "there remains an immense number of fishes to which no other character can be applied than those of the external organs of motion. After an extensive research, I have found that the least objectionable of these characters is the one employed by Artedi and Ray, drawn from the nature of the first rays of the dorsal and anal fins. Thus the ordinary fishes are divided into (1.) MALACOPTERYGII, in which all the rays are soft, with the occasional exception of the first of the dorsal, or of the pectorals: and (2.) ACANTHOPTERYGII, in which the first portion of the dorsal, or of the first dorsal where there are two, is always supported by spinous rays, some of which are also found in the anal, and at least one in the ventral fins."

(77.) The *Malacopterygii*, or soft-rayed fishes, "may be conveniently divided," observes Cuvier, "by a regard to the position of their ventral fins, which are either situated behind the abdomen, as in the *Abdominales;* sometimes placed adjoining the shoulder, as in the *Subbrachiati;* or altogether wanting, as in the *Apodes* (Linn.). It is impossible, however," as Cuvier thinks, "to apply this mode of division to the ACANTHOPTERYGII; and their subdivision in any other way than by that of natural families is a problem that I have hitherto vainly endeavoured to solve. Fortunately, many of these families are possessed of characters nearly as exact as those that could be given to orders."

(78.) We shall first concentrate the foregoing outlines of Cuvier's system in the following table, and then proceed to enumerate more particularly the genera comprised in the families.

I. Osseous Fishes.

					French Names.	*Typical Genera.*
1. Branchia, or gills pectinated.	Upper jaw free.	Acanthopteryges			Percoïdes.	Perca *Linn.*
					Polynemes.	Mullus.
					Mulles.	Trigla.
					Bucca loricatæ.	Sciæna.
					Sciénoïdes.	Sparus.
					Sparoïdes.	Chætodon.
					Chétodonoïdes.	Scomber.
					Scombéroïdes.	Mugil.
					Muges.	Ophicephalus.
					Branchies labyrinthiques.	Lophius.
					Lophioïdes.	Gobius.
					Gobioïdes.	Labrus.
					Labroïdes.	Cyprinus.
		Malacopteryges.	1. *Abdominal.*		Cyprinoïdes.	Silurus.
					Silurioïdes.	Salmo.
					Salmonoïdes.	Clupea.
					Clupeoïdes.	Esox.
					Lucioïdes.	Gadus.
			2. *Sub-branchial.*		Gadoïdes.	Pleuronectes.
					Pleuronectes.	Cyclopterus.
					Discoboles.	Muræna.
			3. *Apodes.*		Murénoïdes.	Balistes.
	Upper jaw fixed to the skull.				Sclerodermes.	Diodon.
					Gymnodontes.	
2. Branchia in tufts.					Lophobranches.	Sygnathus.

II. Cartilaginous Fishes.

Sturioniens.	Acipenser.
Plagiostomes.	Squalus.
Cyclostomes.	Petromyxon.

Division I. — Osseous Fishes.

* Pectinibranchia.

A. *The upper jaw free.*

I. Acanthopteryges.

1. Family. Percoïdes.

* *With two dorsal fins; no canines.*

Perca *Linn.*
Labrax *Cuv.*
Lates *Cuv.*
Centropomus *Lac.*
Grammistes *Cuv.*
Aspro *Cuv.*
Huro.
Etelis.
Niphon.
Enoplosus *Lac.*
Diploprion *Kuhl.*
Apogon *Lac.*
Cheilodipterus *Lac.*
Pomotomus *Risso.*
Ambassis *Comm.*
Lucioperca *Cuv.*

** *With one dorsal fin and canines.*

Serranus.
Anthias *Bloch.*
Merra.
Plectropoma.
Diacope *Cuv.*
Mesoprion *Cuv.*
Acerina *Cuv.*
Rypticus *Cuv.*
Polyprion *Cuv.*
Centropristis *Cuv.*
Gristes *Cuv.*
Cirrhites *Comm.*
Chironemus *Cuv.*
Pomotis *Cuv.*
Centrarchis *Cuv.*
Priacanthus *Cuv.*
Dules *Cuv.*
Therapon *Cuv.*
Datnia.
Pelotes *Cuv.*
Helotis *Cuv.*

*** *With two dorsal fins, and less than six branchial rays.*

Trichodon *Steller.*
Sillago *Cuv.*

**** *More than seven branchial rays.*

Holocentrum *Bloch.*
Myripristis *Cuv.*
Beryx *Cuv.*
Trachichtys *Shaw.*

***** *With jugular ventrals.*

Trachinus *Linn.*
Percis *Bloch.*
Pinguipes *Cuv.*
Percophis *Cuv.*
Uranoscopus *Linn.*

****** *Ventral fins behind the pectoral.*

Polynemus *Linn.*
Sphyræna *Artedi.*
Paralepis *Cuv.*
Mullus *Linn.*

2. Family. Triglidæ (*Sw.*).

Trigla *Linn.*
Prionotus *Lac.*
Peristedion *Lac.*
Dactylopterus *Lac.*
Cephalocanthes *Lac.*
Cottus *Linn.*
Aspidophorus.
Hemitripterus *Cuv.*
Hemilepidotus *Cuv.*
Platycephalus *Bloch.*
Scorpæna *Linn.*
Tænianotus *Cuv.*
Sebastes *Cuv.*
Pterois *Cuv.*
Blepsias *Cuv.*
Apistes *Cuv.*
Agriopus *Cuv.*
Pelor *Cuv.*
Synancea *Bloch.*
Monocentris *Bloch.*
Gasterosteus *Linn.*
Oreosoma *Cuv.*

3. Family. Scienoïdes (*Cuv.*).

Sciæna *Lin.*
Otolithus *Cuv.*
Ancylodon *Cuv.*
Corvina *Cuv.*
Johnius *Bloch.*
Umbrina *Cuv.*
Lonchurus *Bloch.*
Pogonias *Lac.*
Eques *Bloch.*

** *Dorsal fin one.*

Hæmulon *Cuv.*
Prestipoma *Cuv.*
Diagramma *Cuv.*
Lobotes *Cuv.*
Cheilodactylus *Lac.*
Scolopsides *Cuv.*
Micropterus *Lac.*
Amphiprion *Bloch.*
Premnas *Cuv.*
Pomocentrius *Lac.*
Dascyllus *Cuv.*

Glyphisodon *Lac.*
Heliasus.

4. Family. SPAROÏDES (*Cuv.*).

Sargus *Cuv.*
Chrysophris *Cuv.*
Pagrus *Cuv.*
Pagellus *Cuv.*
Dentex *Cuv.*
Cantharus *Cuv.*
Boops *Cuv.*
Oblada *Cuv.*

5. Family. MENIDES (*Cuv.*).

Mæna *Cuv.*
Smaris *Cuv.*
Cæsio *Lac.*
Gerres *Cuv.*

6. Family. SQUAMIPENNES (*Chætodon* Linn.).

Chætodon *Linn.*
Chelmon *Cuv.*
Heniochus *Cuv.*
Ephippus *Cuv.*
Taurichtes *Cuv.*
Holocanthus *Lac.*
Pomocanthus *Lac.*
Platax *Cuv.*
Psettus *Comm.*
Pimelepterus *Lac.*
Dipterodon *Cuv.*
  Brama *Bloch.*
  Pempheris *Cuv.*
  Toxotes *Cuv.*

7. Family. SCOMBEROÏDES (*Cuv.*).

Scomber *Linn.*
  Thynnus *Cuv.*
  Orcynus *Cuv.*
  Auxis *Cuv.*
  Sarda *Cuv.*
  Cybium *Cuv.*
  Thyrsites *Cuv.*
  Gempylus *Cuv.*
Xiphias *Linn.*
  Tetrapterus *Raf.*
  Makaira *Lac.*
  Histiophorus *Lac.*
Centronotus *Lac.*
  Naucrates *Raf.*
  Elacates *Cuv.*
  Lichia *Cuv.*
  Trachinotus *Lac.*
Rynchobdella *Bloch.*
  Macrognathus *Lac.*
  Mastacembelus *Gron.*
Notocanthus *Bloch.*
Seriola *Cuv.*
Nomeus *Cuv.*
Temnodon *Cuv.*
Caranx *Cuv.*
  Citula.
Vomer *Cuv.*
  Olistus *Cuv.*
  Scyris *Cuv.*
  Blepharis *Cuv.*
  Gallus *Cuv.*
  Argyreosus *Cuv.*
Zeus *Linn.*
  Capros *Cuv.*
  Lampris *Retzius.*
  Equula *Cuv.*
  Mene *Lac.*
Stromateus *Linn.*
  Pempla *Cuv.*
  Peprilus *Cuv.*
  Luvarus *Raf.*
Seserinus *Cuv.*
Kurtus *Bloch.*
Coryphæna *Linn.*
  Caranxomorus *Lac.*
  Centrolophus *Lac.*
  Astrodermus *Bon.*
  Pteracles *Gron.*

8. Family. TÆNIOÏDES (*Cuv.*).

* *Mouth lengthened; teeth strong.*

Lepidopus *Gouan.*†
Trichiurus *Linn.*
Gymnetrus *Bloch.*
Stylephorus *Shaw.*

** *Mouth short.*

Cepola *Linn.*
Lophotes *Giorna.*

9. Family. THEUTIDES (*Cuv.*).

Sigánus *Forsk.*
Acanthurus *Lac.*
Prionurus *Lac.*
Naseus *Comm.*
Axinurus *Cuv.*
Priodon *Cuv.*

10. Family. PHARYNGIENS LABYRYNTHIFORMES.

Anabas *Cuv.*
Polyacanthus *Kuhl.*
Macropodus *Lac.*
Helostoma *Kuhl.*
Osphromenus *Comm.*
Trichopodus *Lac.*
Spirobranchus *Cuv.*
Ophicephalus *Bloch.*

11. Family. MUGILOÏDES.

Mugil *Linn.*
Tetragonurus *Risso.*
Atherina *Linn.*

12. Family. GOBIOÏDES.

Blennius *Linn.*
  Myxodes *Cuv.*
  Pholis *Cuv.*
  Salarias *Cuv.*
  Clinus *Cuv.*
  Cirrhribaba *Cuv.*

Gunellus *Cuv.*
Opistognathus *Cuv.*
Zoarcus *Cuv.*
Anarhichas *Artedi.*
Gobius *Linn.*
Gobioïdes *Lac.*
Tæniοïdes *Lac.*
Periophthalmus *Sch.*
Eleotris *Gron.*
Callionymus *Linn.*
Trichonotus *Sch.*
Comephorus *Lac.*
Platypterus *Kuhl.*
Chirus *Steller.*

13. Family. PEDICULATÆ.

Lophius *Linn.*
Chironectes *Cuv.*
Malthe *Cuv.*
Batrachus *Cuv.*

14. Family. LABROÏDES (*Cuv.*).

Labrus *Linn.*
Labrus.
Cheilinus *Lac.*
Lachnolaimus *Cuv*
Julis *Cuv.*
Anampsis *Cuv.*
Crenilabrus *Cuv.*
Coricus *Cuv.*
Epibulus *Cuv.*
Clepticus *Cuv.*
Gomphosus *Cuv.*
Xirichythys *Cuv.*
Chromis *Cuv.*
Cychla *Bloch.*
Plesiops *Cuv.*
Malacanthus *Cuv.*
Scarus *Linn.*
Calliodon *Cuv.*
Odax *Cuv.*

15. Family. FISTULARIDÆ (*Sch.*).

Fistularia *Linn.*
Aulostomus *Lac.*
Centriscus *Linn.*
Amphisile *Klein.*

II. MALACOPTERYGII.

Order 1. *Malacopterygii abdominales.*

1. Family. CYPRINIDÆ.

Cyprinus *Linn.*
Cyprinus *Cuv.*
Barbus *Cuv.*
Gobio *Cuv.*
Tinca *Cuv.*
Cirrhinus *Cuv.*
Abramis *Cuv.*
Labeo *Cuv.*
Catastomus *Le Sueur.*
Leuciscus *Klein.*
Gonorynchus *Gron.*
Cobites *Linn.*
Anableps *Artedi.*
Pœcilia *Sch.*
Lebias *Cuv.*
Fundulus *Lac.*
Molinesia *Le Sueur.*
Cyprinodon *Lac.*

2. Family. ESOCES (*Cuv.*).

Esox *Linn.*
Esox.
Galaxias *Cuv.*
Alepocephalus *Risso.*
Microstoma *Cuv.*
Stomias *Cuv.*
Chauliodus *Sch.*
Salanx *Cuv.*
Belone *Cuv.*
Sairis *Raf.*
Hemiramphus *Cuv.*
Exocetus *Linn.*
Mormyrus *Linn.*

3. Family. SILURIDÆ (*Cuv.*).

Silurus *Linn.*
Schilbe *Cuv.*
Mystus *Artedi.*
Pimelodus *Lac.*
Bagrus *Cuv.*
Synodontis *Cuv.*
Ageniosus *Lac.*
Doras *Lac.*
Heterobranchus *Geoff.*
Clarias *Gron.*
Plotosus *Lac.*
Callichthys *Linn.*
Malapterurus *Lac.*
Aspredo *Linn.*
Loricaria *Linn.*
Hypostomus *Lac.*

4. Family. SALMONIDES (*Cuv.*).

Salmo *Linn.*
Osmerus *Artedi.*
Mallotus *Cuv.*
Thymallus *Cuv.*
Coregonus *Cuv.*
Argentina *Cuv.*
Curimata *Cuv.*
Anostomus *Cuv.*
Gasteropelecus *Bloch.*
Piabucus *Cuv.*
Serrasalmo *Lac.*
Tetragonopterus *Artedi.*
Chalceus *Cuv.*
Myletes *Cuv.*
Hydrocyon *Cuv.*
Citharinus *Cuv.*
Saurus *Cuv.*
Scopelus *Cuv.*
Aulopus *Cuv.*
Sternoptyx *Herm.*

5. Family. CLUPEÆ.

Clupea *Linn.*
Clupea.
Alosa *Cuv.*
Chatœssus *Cuv.*
Gnathobolus *Sch.*
Pristigaster *Cuv.*
Notopterus *Lac.*
Engraulis *Cuv.*
Thryssa.
Megalops *Lac.*
Elops *Linn.*
Butirinus *Comm.*
Chirocentrus *Cuv.*
Hyodon *Le Sueur.*
Erythrinus *Gron.*
Amia *Linn.*
Sudis *Cuv.*
Osteoglossum *Vana.*
Lepisosteus *Lac.*
Polypterus *Geoff.*

Order 2. *Ventral fin beneath the pectoral.*

6. Family. GADITES.

Gadus *Linn.*
Morrhua *Cuv.*
Merlangus *Cuv.*
Merlucius *Cuv.*
Lota *Cuv.*
Motella *Cuv.*
Brosmius *Cuv.*
Brotula *Cuv.*
Phycis *Artedi.*
Raniceps *Cuv.*
Lepidoleprus *Risso.*

7. Family. PLEURONECTIDÆ.

Pleuronectes *Linn.*
Platessa *Cuv.*
Hippoglossus *Cuv.*
Rhombus *Cuv.*
Solea *Cuv.*
Monochirus *Cuv.*
Achirus *Lac.*
Plagusia *Cuv.*

8. Family. DISCOBOLI.

Lepidogaster *Gouan.*
Gobiesox *Lac.*
Cyclopterus *Linn.*
Lumpus *Cuv.*
Liparis *Artedi.*
Echeneis *Linn.*

Order 3. *Ventral fins wanting.*

9. Family. ANGUILLIFORMES.

Muræna *Linn.*
Anguilla *Thunb.*
Muræna.
Ophisurus *Lac.*
Gymnothorax *Bloch.*
Sphagebranchus *Bloch.*
Apterichtes *Dum.*
Monopterus *Comm.*
Synbranchus *Bloch.*
Alabes.
Ophiognathus *Harwood.*
Gymnotus *Linn.*
Carapus *Cuv.*
Sternarchus *Sch.*
Gymnarchus *Cuv.*
Leptocephalus *Pennant.*
Ophidium *Linn.*
Fierasfer *Cuv.*
Ammodytes *Linn.*

Order 4. *Lophobranches.*

10. Family. SYNGNATHIDÆ.

Syngnathus *Linn.*
Hippocampus *Cuv.*
Solenostomus.
Pegasus *Linn.*

Order 5. *Plectognathes.*

11. Family. GYMNODONTES.

Diodon *Linn.*
Tetraodon *Linn.*
Cephalus *Sch.*
Triodon *Cuv.*

12. Family. SCHERODERMES.

Balistes *Linn.*
Monocanthus *Cuv.*
Aluterus *Cuv.*
Triacanthus *Cuv.*
Ostracion *Linn.*

Division II.—CARTILAGINOUS FISHES.

Order 1. *Sturiones.*

Acipenser *Linn.*
Spatularia *Shaw.*
Chimæra *Linn.*
Callorhynchus.

Order 2. *Chondropterygii.*

1. Family. SELACHII.

Squalus *Linn.*
Scyllium *Cuv.*
Carcharias *Raf.*
Lamna *Cuv.*
Galeus *Cuv.*

Mustelus *Cuv.*
Notidanus *Cuv.*
Selache *Cuv.*
Cestracion *Cuv.*
Spinax *Cuv.*
Centrina *Cuv.*
Scymnus *Cuv.*
Zygæna *Antiq.*
Squatina *Dum.*
Pristis *Lath.*
Raia *Linn.*
Rhinobatus *Schn.*
Rhina *Schn.*
Torpedo *Antiq.*
Raia *Linn.*
Trygon *Antiq.*
Anacanthus *Ehren.*
Myliobatis *Dum.*
Rhinoptera *Kuhl.*
Cephaloptera *Dum.*

2. Family. Suctorii.

Petromyzon *Linn.*
Myxine *Linn.*
Heptatremus *Dum.*
Gastrobranchus *Bloch.*
Ammocœtes *Dum.*

(79.) Having already offered a few general remarks on the foundations of this system, we shall only advert, in this place, to some objections regarding the nomenclature of certain groups. M. Cuvier, in making his divisions of the Linnæan genera, generally places the original name for designating the group; but in several instances he gives to every one of his divisions a *new* name; so that, although it seems at first as if the Linnæan denomination was preserved, it is, in fact, completely done away with, and only remains an indication of a genus not adopted. One instance of this will suffice to explain our meaning. The well known genus *Gadus* is divided, very properly, into several others, but is not retained or restricted to any one; so that, if we adopt all M. Cuvier's new generic names, we must totally reject, *as such*, the genus *Gadus:* no such group, consequently, is to be found in the *Règne Animal.* As this, we presume, never could have been intended by the illustrious author, we have retained this and other original names to that division of a Linnæan genus which seems to us the most typical. M. Cuvier's generic names, in general, are well and harmoniously compounded; but many have no claim on the score of priority; and a few others, as *Vomer, Saurus, Barbus,* &c., are founded on principles which he himself has rejected in all other instances: these blemishes have therefore been corrected, and that name adopted which has the priority.*

* Another practice has recently been introduced by one or two foreign naturalists of some eminence, who do not appear to be aware of the consequences to which it leads; we think it, however, almost as objectionable

(80.) The prince of Musignano's arrangement of this class is the most recent.* As we think it contains some decided improvements upon M. Cuvier's, we shall lay the following abstract of it before the reader, particularly as we know that it is the result of no inconsiderable share of knowledge and of attention to these animals in their living state. It is not so much in the primary divisions (which, like those of M. Cuvier, are entirely arbitrary), as in the series in which some of the genera are placed, that we conceive these improvements will be found. The number of species which the noble author believes to be comprised in each genus is added.

I. Order. — Acanthopterygii.

1. Family. Percidæ.

1. *Percini.*

Perca	Temperate rivers	11
Labrax	Temp. seas	7
Lates	Africa, India	3
Centropomus	America	1
Lucioperca *Cuv.*	Black Sea	4
Huro *Cuv.*	Lake Huron	1
Etelis *Cuv.*	Europe	1
Niphon *Cuv.*	Java	1
Enoplosus *Lac.*	Australia	1
Diploprion *Kuhl*	Java	1
Apogon *Lac.*	Warm seas	22
Cheilodipterus *Lac.*	India	3
Pomatomus *Risso*	Medit.	1
Ambassis *Comm.*		12
Priopis *Kuhl*	Java	1
Aspro *Cuv.*	Europ. rivers	2
Grammistes *Cuv.*	India	2
Anthias *Bon.*	Ind., Am., Eur.	7
Serranus *Cuv.*	All seas	22
Merrus *Cuv.*	Ditto	98
Plectropoma *Cuv.*	Ind., Am.	14
Diacope *Cuv.*	India	33
Mesoprion *Cuv.*	Tropics	48
Acerina *Cuv.*	Europ. rivers	3
Polyprion *Cuv.*	Warm seas	1
Pentaceros *Cuv.*	Africa	1
Centropristis *Cuv.*	Warm seas	10
Grystes †	Am. rivers	2
Aprion *Cuv.*		1
Rypticus *Cuv.*	Am.	2
Apsilus *Cuv.*	Atlantic	1
Cirrhites *Comm.*	India	6
Chironemus *Cuv.*	Australia	1
Pomotis *Cuv.*	Am. rivers	8
Centrarchus *Cuv.*	Ditto	7
Bryttus *Cuv.*	Ditto	3
Priacanthus *Cuv.*	Atlantic	15
Dulichethys ‡ *Bon.*	Warm seas	11
Therapon *Cuv.*	Red Sea	10
Datnia § *Cuv.*	India	3
Pelates *Cuv.*	Ditto	3
Helotes *Cuv.*	Australia	3
Nandus *Cuv.*	Ind. rivers	1
Trichodon *Cuv.*	Arctic	1
Sillago *Cuv.*	India	7
Rhynchithys *Cuv.*	Ditto	1

as the former, although on a different ground. If a genus is to be divided, the divider not only affixes his own name as founder of the new group, but he does the same to the original one; so that, in fact, the merit of the original founder of the genus is completely cancelled, and the generic name, although retained, seems as if it originated solely in him who divides it. If this is once allowed, there is no calculating the confusion, not to say the injustice, that will follow: the fame or reputation of no one, who has defined and named a group, is safe; since it may be cancelled by the very first who thinks it necessary to divide it. On this principle, the genus *Gadus*, in our synopsis, would be ours, not Linnæus's; and *Teuthis* would be recorded in our systems, not as an effective genus made by Linnæus, but by Bonaparte.

* Saggio di Una Distribuzione Metodica degli Animali Vertebrati; di C. L. Bonaparte, Principe di Musignano. Roma, 1831.

† Micropterus *Lac.* ‡ Dules *Cuv.* § Coius *Buchan.*

Holocentrum *Bloch*	Warm seas	
Myripristis *Cuv.*	Ditto	11
Holocentrum *C.*	Warm seas	19
Beryx *Cuv.*	Australia	1
Trachicthys *Shaw*	Ditto	1

2. *Trachinini.*

Trachinus *Linn.*	Medit.	4
Percis *Bloch*	India	12
Aphritis *Cuv.*	Atlantic	1
Pinguipes *Cuv.*	Brazil	1
Percophis *Cuv.*	Ditto	1
Bovichthus *Cuv.*	Chili	1
Uranoscopus *Linn.*	General	13

3. *Polynemini.*

Polynemus *Gron.*	Warm seas	15
Aplodactylus *Cuv.*	Chili	1

2. Family. SPHYRÆNIDÆ.

Sphyræna *Lac.*	General	11
Paralepis *Risso*	Medit.	4

3. Family. MULLIDÆ.

Mullus *Linn.*		
Mullus *Cuv.*	Europe	2
Upeneus *Cuv.*	Warm seas	40

4. Family. TRIGLIDÆ.

1. *Triglini.*

Trigla *Linn.*	General	15
Prionotes	America	4
Peristidion *Lac.*	Medit.	1
Dactylopterus	Warm seas	2
Cephalacanthus	Ditto	1

2. *Cottini.*

Cottus *Linn.*	Atlantic	19
Aspidophorus *Cuv.*	Ditto	9
Platycephalus *Bloch*	India	21
Hoplichthys *Cuv.*	Japan	1
Bembras *Cuv.*	Ditto	1
Hemitripterus *Cuv.*	Atlantic	1

3. *Scorpænini.*

Hemilepidotus *Cuv.*	Atlantic	1
Scorpæna *Linn.*	General	19
Sebastes *Cuv.*	Europe	10
Pterois *Cuv.*	India	7
Tænianotis *Lac.*		1
Blepsias *Cuv.*	Pacific	2
Agriopus *Cuv.*	Atlantic	3
Apistus *Cuv.*	India	15
Minous *Cuv.*	Ditto	2
Pelor *Cuv.*	India	4
Synanceia *Bloch*	Ditto	6

4. *Gasterosteini.*

Monocentris *Cuv.*	Japan	1
Hoplostethus *Cuv.*	Medit.	1
Gasterosteus *Linn.*	Arctic	16
Oreosoma *Cuv.*	Atlantic	1

5. Family. SCIÆNINI.

Sciæna *Linn.*	Warm lat.	3
Otolithus *Cuv.*	Ditto	13
Ancylodon *Cuv.*	Ditto	2
Corvina *Cuv.*	Ditto	17
Johnius *Bloch*	Ditto	16
Leiostomus *Lac.*	Atlantic	2
Larimus *Cuv.*	Ditto	2
Nebris *Cuv.*	Ditto	1
Lepipterus *Cuv.*	Ditto	1
Boridia *Cuv.*	Ditto	1
Conodon *Cuv.*	Ditto	1
Eleginus *Cuv.*	Ditto	1
Eques *Bloch*	Ditto	3
Umbrina *Cuv.*	India, &c.	9
Lonchurus *Bloch*		2
Pogonathus *Bon.**		2
Micropogonias *Bon.*	Atlantic	3
Hæmulon *Cuv.*		
Pristipoma *Cuv.*	India	30
Diagramma *Cuv.*	Ditto	20
Lobotes *Cuv.*	Ditto	4
Scalopsides *Cuv.*	Ditto	19
Cheilodactylus *Cuv.*	Ditto	5
Latilus *Cuv.*	Ditto	2
Macquaria *Cuv.*	Australia	1

2. *Pomocentrini.*

Amphiprion *Bloch*	India	12
Premnas *Cuv.*	Ditto	3
Pomacentrus *Cuv.*	Ditto	17
Dascyllus *Cuv.*	India	
Glyphisodon *Lac.*	Atlantic	30
Etroplus *Cuv.*	India	3
Heliases *Cuv.*	Am., Ind.	6

6. Family. SPARIDÆ.

1. *Sparini.*

Sargus *Klein*	Warm seas	14
Charax *Risso*	Medit.	1
Sparus *Linn., Bon.*	Ditto	22
Pagrus *Cuv.*	Warm seas	12
Pagellus *Cuv.*	Ditto	10

2. *Denticini.*

Dentex *Cuv.*	Warm seas	27
Pentapus *Cuv.*	India	8

* *Pogonias* of Cuvier, &c.; but this name cannot be retained, having long been used in ornithology.

3. *Lethrinini.*

Lethrinus *Cuv.*	Warm seas	44

4. *Cantharini.*

Cantharus *Cuv.*	Warm seas	12

5. *Obladini.*

Box *Cuv.*	Warm seas	4
Oblada *Cuv.*	Med., Aust.	2
Cantharus *Cuv.*	Medit.	1
Crenidens *Cuv.*	Red Sea	1

7. Family. MÆNIDÆ.

1. *Mænini.*

Mæna *Cuv.*	Medit.	4
Smaris *Cuv.*	Atlantic	10

2. *Cæsionini.*

Cæsio *Comm.*	India	9
Gerres *Cuv.*	Pacif., Atlant.	18
Aphareus *Cuv.*	India	2

8. Family. CHÆTODONTINI.

Chætodon *Linn.*	Torrid seas	61
Chelmon *Cuv.*	India	2
Heniochus *Cuv.*	Ditto	5
Zanclus *Cuv.*	Ditto	2
Ephippus *Cuv.*	Am., India	4
Drepanis *Cuv.*	India	2
Scatophagus *Cuv.*	Ditto	5
Taurichthys *Cuv.*	Ditto	5
Holocanthus *Lac.*	Ditto	23
Pomacanthus *Cuv.*	Am.	6
Platax *Cuv.*	India	14
Psettus *Comm.*	India	3

2. *Pimeleptini.*

Pimelepterus *Lac.*	Pacific	10
Dipterodon *Cuv.*	Cape	1
Scorpis *Cuv.*	Australia	1
Brama *Bloch*	India	3
Pempheris *Cuv.*	Pacific	8
Toxotes *Cuv.*	India	1

9. Family. SCOMBRIDÆ.

1. *Scombrinæ.*

Scomber *Linn.*	General	12
Thynnus *Cuv.*	Ditto	11
Auxis *Cuv.*	Ditto	3
Pelamis *Cuv.*	Warm seas	2
Cybium *Cuv.*	India	16
Thyrsites *Cuv.*	Warm seas	3
Gempylus *Cuv.*	Atlantic	4

2. *Trichiurini.*

Lepidopus *Gouan*	Atlantic	1
Trichiurus *Linn.*	India, &c.	3

3. *Xiphiadini.*

Xiphias *Cuv.*	Medit.	1
Histiophorus *Lac.*	Warm seas	3
Tetrapterus *Lac.*	Ditto	2
Makaira *Lac.*	Atlantic	1

4. *Centronotini.*

Naucrates *Raf.*	Warm seas	4
Elacates *Cuv.*	Ditto	5
Centronotus *Lac.*		
Lichia *Cuv.*	Medit.	4
Chorinemus *Cuv.*	Pacific	16
Trachinotus *Cuv.*	India	23
Apolectus *Cuv.*	Ditto	1
Macrognathus *Lac.*		
Rhynchobdella *Cuv.*	Asia	1
Mastacembelus *Cuv.*	Ditto	8
Notocanthus *Cuv.*	Atlantic	1

5. *Carancini.*

Caranx *Lac.*	Universal	16
Carangus *Cuv.*	India, &c.	20
Citula *Cuv.*	Medit.	4

6. *Vomerini.*

Seriola *Cuv.*	Universal	7
Nomeus *Cuv.*	America	1
Temnodon *Cuv.*	Pacific	2
Olistus *Cuv.*	India	1
Scyris *Cuv.*	Egypt	2
Blepharis *Cuv.*	America	4
Alectris *Raf.**	India, Am.	4
Argyneosus *Lac.*	America	6
Vomer *Cuv.*	Ditto	10

7. *Zeini.*

Zeus *Linn.*	Medit., Atlant.	2
Capros *Lac.*	Medit.	1
Lampris *Retz* †	Ditto	1
Equula *Cuv.*	India	15
Mene *Lac.*	Ditto	1

8. *Coryphænini.*

Stomateus *Linn.*	Medit., Atl.	12
Peprilus *Cuv.*	America	5
Luvarus *Raf.*	Atlantic	1
Seserinus *Cuv.*	Medit.	1
Kurtus *Bloch*	India	3
Coryphæna *Linn.*	Atlantic	10
Caranxomorus *Lac.*	Atlan.	3
Centrolophus *Lac.*	Ditto	4
Pteraclis *Gron.* ‡	America	1

* Gallus *Lacepede.*

† Chrysotosus *Lacepede.*

‡ *Pteridium* of Scopoli, and *Oligopodus* of Lacepede.

10. Family. CEPOLIDÆ.

Gymnetrus *Bl.*	India, Med., &c.	9
Stylephorus *Shaw*	Trop. Am.	1
Cepola *Linn.*	Medit., Pacif.	3
Lophotes *Giorna*	Medit.	1

11. Family. TEUTHIDIDÆ.

Siganus *Forsk*	India	20
Teuthis *Linn.*	Warm seas	25
Acanthurus *Lac.*		
Scopas *Bon.**		
Ctenodon *Bon.*		
Prionurus *Lac.*	Warm seas	2
Naseus *Comm.*	Ditto	11
Axinurus *Cuv.*	India	1
Priodontichtys *Bon.* †	Ditto	1

12. Family. OPHIOCEPHALIDÆ.

1. *Anabatini.*

Anabas *Cuv.*	Fresh waters, Asia	1
Helostoma *Kuhl*	Ditto	1
Polycanthus *Kuhl*	Ditto	3
Colisa *Cuv.*	Ganges	9
Macropodus *Lac.*		2
Osphromenus *Com.*	Ind. rivers	3
Spirobranchus *Cuv.*	Af. rivers	1

2. *Ophiocephalini.*

Ophiocephalus *Bl.*	Ind. rivers	20

13. Family. MUGILIDÆ.

1. *Mugillini.*

Mugil *Linn.*	General	30

2. *Tetragonurini.*

Tetragonurus *Risso*	Medit.	1

3. *Atherinini.*

Atherina *Linn.*	Medit.	20
Aphia *Risso*	Ditto	1

14. Family. GOBIDÆ.

1. *Blennini.*

Blennius *Linn.*	General	25
Pholis *Artedi*		
Tripterygion	Medit.	1
Myxodes *Cuv.*	India	5
Salarias *Cuv.*	Ditto	9
Clinus *Cuv.*	Medit.	16
Cirrhibarbus *Cuv.*	India	1
Murænoïdes *Lac.*	Atlantic	3
Opistognathus *Cuv.*	India	1
Zoarces *Cuv.*	Medit.	5
Anarhichas *Artedi*	Atlantic	3

2. *Gobini.*

Gobius *Linn.*	General	50
Gobioïdes *Lac.*	India	6
Tænioïdes *Lac.*	Ditto	1
Periopthalmus *Sch.*	Ditto	5
Eleotris *Gron.* ‡	General	10

3. *Callionymini.*

Callionymus *Cuv.*	Medit.	18
Trichonotus *Sch.*	India	4
Comephorus *Lac.*	Baikal	1
Platypterus *Kuhl*	India	2
Chirus *Steller*	Kamtch.	7

15. Family. LOPHIDÆ.

Lophius *Linn.*	Med., Atlant.	4
Antennarius §	Tropics	16
Malthe *Cuv.*	Ditto	8
Batrachus *Bloch*	Pacific	12

16. Family. LABRIDÆ.

1. *Labrini.*

Labrus *Linn.*	General	40
Crenilabrus *Cuv.*	Warm seas	90
Cheilinus *Lac.*	India	12
Lachnolaimus *Cuv.*	Am.	4
Julus *Cuv.*	Warm seas	40
Anampses *Cuv.*	India	2
Coricus *Cuv.*	Medit.	3
Epibolus *Cuv.*	India	1
Clepticus *Cuv.*	W. Indies	1
Elops *Comm.* ‖	India	5
Xirichthys *Cuv.*	Warm seas	12

2. *Chromidini.*

Malacanthus *Cuv.*	India	3
Chromis *Cuv.*	Nile	10
Cychla *Bloch*	India	16
Plesiops *Cuv.*	Ditto	4

3. *Scarini.*

Scarus *Linn.*	Warm seas	29
Calliodon *Cuv.*	India	7
Odax *Cuv.*	Ditto	4

17. Family. FISTULARINI.

1. *Fistularini.*

Fistularia *Linn.*	Warm seas	5
Aulostomus *Lac.*	India	1

2. *Centriscini.*

Centriscus *Linn.*	Medit.	
Amphisile *Klein.*	India	1

* Scopus is already used in ornithology.
† *Priodon* of Cuvier.
§ Chironectes *Cuv.*
‡ Prochilus *Cuv.*
‖ Gomphosus *Lac.*

II. Order. — MALACOPTERYGII.

18. Family. CYPRINIDÆ.

1. *Cyprinini.*

Cyprinus *Linn.*	Fresh waters	
Cyprinus *Cuv.*	General	15
Barbus *Cuv.*	Ditto	24
Gobio *Cuv.*	Europe, Asia	6
Tinca *Cuv.*	Eur., As., Af.	4
Cirrhinus *Cuv.*	India	4
Abramis *Cuv.*	Eur., Asia	10
Labeo *Cuv.*	Af., Am., As.	7
Catostomus *Le Sueur*	Am.	20
Leuciscus *Klein*	General	131
Chela *Hamilton*	India	3
Gonorhynchus *Gron.*	Africa	1
Cobites *Linn.*	E. Asia	16

2. *Anableptini.*

Anableps *Bloch*	Am. rivers	1

3. *Pœcilini.*

Pœcilia *Sch.*	Am. rivers	6
Lebias *Cuv.*	Med., Afr.	6
Fundulus *Lac.*	America	5
Molinesia *Le Sueur*	Ditto	3
Cyprinodon *Lac.*	Eur., Am.	4

19. Family. ESOCIDÆ.

1. *Esocini.*

Esox *Linn.*	Eur., Am.	4
Galaxias *Cuv.*	America	2
Alepocephalus *Risso*	Medit.	1
Microstoma *Cuv.*	Ditto	1
Stomias *Cuv.*	Ditto	2
Chauliodus *Sch.*	Ditto	1
Salanx *Cuv.*	Atlantic	1
Ramphistoma *Raf.*	General	15
Scombrisox *Lac.*	Medit.	3
Hemiramphus *Cuv.*	Tropics	14

2. *Exocetini.*

Exocetus *Linn.*	Tropics, &c.	12

3. *Mormyrini.*

Mormyrus *Linn.*	Af. rivers	16

20. Family. SILURIDÆ.

1. *Silurini.*

Silurus *Linn.*	Trop. rivers	
1 Silurus *Artedi*	Europe	9
Schilbe *Cuv.*	Nile	5
Mystus *Artedi* *	Am. riv.	7
Pimelodus *Lac.*		
Bagrus	Nile, India	24
Sorubium *Spix*	America	7
Hypopthalmus *Spix*	Ditto	2
Pimelodus *Cuv.*	Ditto	40
Synodontis	Nile	3
Argeniosus *Lac.*	Ganges	3
Heterobranchus *Geoff.*		
Clarias *Gron.*	India	5
Heterobranchus *Geoff.*	Do.	2
Plotosus *Lac.*	Asia	2
Platystacus *Bloch*	Ditto	2
Plotosus *Lac.*	Ditto	2
Callichthys *Linn.*	Ditto	2
Malapterurus *Lac.*	Africa	2

2. *Loracarini.*

Aspredo *Linn.*	America	5
Loricaria *Linn.*	Ditto	
Loricaria	Ditto	4
Hypostomus *Lac.*	Ditto	2

21. Family. SALMONIDÆ.

1. *Salmonini.*

Salmo *Linn.*	General	50
Osmerus *Artedi*	Eur., Am.	1
Mallatus *Cuv.*	Atlantic	1
Thymallus *Cuv.*	Eur., Am.	3
Coregonus *Cuv.*	Ditto	15
Argentina *Linn.*	Medit.	1
Curimatus *Cuv.*	America	10
Anastomus *Cuv.*	Ditto	1
Gasteropelicus *Bloch*	India	1
Characinus *Artedi*	America	10
Serrasalmo *Lac.*	Ditto	5
Tetragonopterus *Art.*	Ditto	3
Chalceus *Cuv.*	Ditto	3
Myletes *Cuv.*	Am., Nile	6

2. *Aulopodini.*

Hydrocyon *Cuv.*	Trop. rivers	9
Citharinus *Cuv.*	Nile	3
Saurus *Cuv.*†	General	20
Scopilus *Cuv.*	Medit.	3
Aulopus *Cuv.*	Ditto	1
Sternoptyx	Ditto	2

22. Family. CLUPEIDÆ.

1. *Clupeini.*

Clupea *Linn.*		
Clupea	General	12
Alosa *Cuv.*	Ditto	20
Chætoessus *Cuv.*	Ind., Am.	8
Pomolobus *Raf.*	Ohio	2
Dorosoma *Raf.*	Ohio	1
Notemigonus *Raf.*	Ditto	2
Odontognathus *Lac.*	America	1

* Doras *Lac.* † Laurida *Aristotle*, and including Harpodon *Le Sueur.*

Pristogaster *Cuv.*	Atlantic	4
Notopterus *Lac.*	Asia	1
Engraulis *Cuv.*		
Engraulis	General	12
Thryssa	India	4
Alpismaris	Medit.	2
Megalops *Lac.*	Am., Asia	2
Elops *Linn.*	Ind., Am.	4
Butirinus *Comm.*	Ditto	5
Chirocentrus *Cuv.*	India	1
Hyodon *Le Sueur*	Am.	2

2. *Amini.*

Erythrichthys *Bon.**	Warm rivers	6
Amia *Linn.*	America	1
Sudis *Cuv.*	Amer., Afr.	3
Osteoglossum *Vand.*	Brazil	1
Lepisosteus *Lac.*	America	7
Polypterus *Geoff.*	Nile	2

(Tribe 2. *Subbrachianii.*)

23. Family. GADIDÆ.

1. *Gadini.*

Gadus *Linn.*		
Morrhua *Cuv.*	Atlantic, &c.	12
Merlangus *Cuv.*	Ditto	4
Merlucius *Cuv.*	Ditto	3
Lota *Cuo.*	Medit.	5
Motella *Cuv.*	Atlantic	5
Brosmius *Cuv.*	Ditto	2
Brotula *Cuv.*	W. Indies	1
Physis *Artedi*	Medit., &c.	4
Raniceps *Cuv.*	Atlantic	2

2. *Macrourini.*

Macrourus *Bloch*	Medit.	3

24. Family. PLEURONECTIDÆ.

Pleuronectus, *Linn.*		
Platessa *Cuv.*	Atlantic	10
Hippoglossus *Cuv.*	India, Europe	10
Bothus *Raf.*	General	20
Solea *Cuv.*		
Solea *Cuv.*	Ditto	20
Monochir *Cuv.*	Ditto	7
Achirus *Lac.*	India	4
Plagusia *Br.*	Ditto	6

25. Family. CYCLOPTERIDÆ.

Lepadogaster *Gouan*	General	11
Gobiesox *Lac.*	Med., Atl.	4
Cyclopterus *Linn.*	Atlantic	8
Liparis *Artedi*	Ditto	4

26. Family. ECHENEIDIDÆ.

Echeneis *Linn.*		4

(Tribe 3. *Apodes.*)

27. Family. OPHIDIDÆ.

Ophidium *Linn.*	Medit., &c.	5
Fierasfer *Cuv.*	Ditto	2
Ammodytes *Linn.*	Ditto	3
Leptocephalus *Gron.*	Ditto	6

28. Family. MURÆNIDÆ.

1. *Gymnotini.*

Eremophilus *Humb.*	Am. rivers	1
Gymnarchus *Cuv.*	Nile	1
Gymnotus *Linn.*	America	2
Carapus *Cuv.*	Ditto	5
Apternarchus *Schn.*	Ditto	2

2. *Muræinini.*

Saccopharynx *Mitchell*†	Amer.	2
Muræna *Antiq.*	General	20
Anguilla *Antiq.*	Ditto	6
Conger *Cuv.*	Ditto	10
Ophisurus *Lac.*	Ditto	12

3. *Apterichthini.*

Sphagebranchus *Bloch*	India	6
Apterichthys *Dum.*	Medit.	2
Synbranchus *Bloch*	India	5
Alabes *Cuv.*	India	1

29. Family. SYNGNATHIDÆ.

Syngnathus *Linn.*	General	25
Typhle *Raf.*		
Sephostoma *Raf.*		
Nerophis *Raf.*		
Hippocampus *Cuv.*	Warm seas	12
Solenostomus *Lac.*	India	1
Pegasus *Linn.*	India	5

III. Order.—PLECTOGNATHI.

30. Family. TETRAODONTIDÆ.

Diodon *Linn.*	Warm seas	20
Tetraodon *Linn.*	Ditto	30
Cephalus *Shaw*	Ditto	7
Triodon *Cuv.*	India	1

31. Family. BALISTIDÆ.

Balistes *Linn.*		
Balistes *Linn.*	Warm seas	32
Balistopus *Tiles.*	Ditto	1
Monacanthus *Cuv.*	Ditto	20
Aluterus *Cuv.*	India, &c.	10
Triacanthus *Cuv.*	India	1
Ostracion *Linn.*	Tropics	26

* Erythrinus *Gron.*

† Ophiognathus *Harwood.*

IV. Order. — CARTILAGINEI.

32. Family. ACIPENSERIDÆ.

Acipenser *Linn.*	General	12
Polyodon *Lac.*	America	1

33. Family. CHIMÆRIDÆ.

Chimæra *Linn.*	Med., Arctic	1
Callorhynchus *Gron.*	Pacific	1

34. Family. SQUALIDÆ.

Scyllium *Cuv.*	General	15
Pristiurus *Bon.*	Medit.	1
Squalus *Linn.*		
Carcharias *Raf.*, *Cuv.*	General	20
Alopius *Raf.*	Medit.	1
Rhineodon *Smith*	Atlantic	1
Somniosus *Le Sueur*	Ditto	1
Lamna *Cuv.*		3
Galeus *Raf.*, *Cuv.*		4
Mustelus *Cuv.*		3
Notidanus *Cuv.*		4
Hexanchus *Raf.*		
Heptranchus *Raf.*		
Selache *Cuv.*	Atlantic, &c.	2
Cestracion *Cuv.*	Australia	1
Spinax *Cuv.*	Medit., &c.	5
Centrina *Cuv.*	Medit., &c.	3
Scymnus *Cuv.*	General	7
Zygæna *Antiq.*, *Cuv.*	India	4
Squatina *Dum.*	Med., Am.	6

36. Family. RAIDÆ.

Pristis *Lath.*	Warm seas	7
Rhinobatus *Sch.*	Ditto	11
Rhina *Sch.*	Ditto	4
Torpedo *Dum.*	Ditto	11
Leiobatus *Blain.*		
Dasybatus *Blain.*		
Trygon *Antiq.*	Ditto	20
Anacanthus *Ehrenb.*	Red sea	3
Myliobates *Dum.*	Warm seas	11
Rhinoptera *Kuhl*	Ditto	4
Cephaloptera *Dum.*	Ditto	3

36. Family. PETROMYZONIDÆ.

Gastrobranchus *Bloch*	Atlantic	2
Petromyzon *Linn.*	General	6
Myxine *Linn.*	India	1
Ammocœtus *Dum.*	Europe	2

Total number of the species 3586

(81.) We are not, in general, favourable to these expositions of methods which we do not adopt; and we have, therefore, somewhat abridged the foregoing by omitting the divisions of the sections, orders, &c.; but the families, genera, &c. are all included, so that the reader will at once perceive in what way our own series differs from both this and M. Cuvier's. We regret, however, that our space will not allow us to insert a similar exposition of the arrangement of professor Rafinesque, because, although artificial, there is much to admire in it, and he was the first to commence that general breaking up of the Linnæan genera into minor groups, which Cuvier and his disciples subsequently followed. We shall, however, in the course of this work, introduce several of the genera and sub-genera proposed by this able and zealous zoologist, and shall substitute his names for those of other writers, whenever they have a prior claim, and whenever his groups can be sufficiently made out.

(82.) Of NATURAL SYSTEMS of ichthyology, or those

which are framed with a reference to certain general laws of creation, real or supposed*, we are only acquainted with those that have at different periods been proposed by M. Oken, one of the most celebrated among those metaphysical naturalists who have arisen, of late years, in Germany. That we may not be thought to undervalue the labours of those whose aim, like our own, is to "establish resemblances and explain analogies," we shall here enumerate these systems, which M. Oken, at different periods, has successively drawn up.

M. Oken's first system is founded according to an idea he entertained of the predominance which water has on the different parts of the body; he accordingly conceives that all fish should be arranged under the following orders:—

I.	Poissons Ventriers.	Bony fish, without scales.
II.	——— Thoraciers.	——— with scales.
III.	——— Membriers.	The genera *Fistularia*, *Pegasus*, *Diodon*, &c.
IV.	——— Tetiers.	*Petromyzon*, *Squalus*, and *Raia*, Linn.

In the second, published five years after†, this idea is abandoned for another, by which M. Oken believes he can arrange the whole class so as to represent what he thinks to be the seven primary divisions of the animal kingdom. A general idea of this system will be obtained by the following enumeration of its chief divisions. He first divides the whole into two great groups — *Osseous* and *Cartilaginous* fishes: under the first he brings in six of his orders, leaving only the seventh in the last. These seven orders are thus designated:—

* See definitions of natural and artificial systems, Classif. of Animals.
† Cuvier, Hist. Nat. des Poissons, tom. i. p. 258.

I.	Poissons Zoophytes,	as the eels, *Anguilla*, &c.
II.	——— Vers,	*Gadus*, *Blennius*, *Scomber*, &c.
III.	——— Insectes,	*Labrus*, *Sciènes*.
IV.	——— Poissons,	*Mugil*, *Cyprinus*.
V.	——— Reptiles,	*Cobites*, *Silurus*, *Salmo*, *Esox*.
VI.	——— Oiseaux,	*Callionyus*, *Gobius*, *Chætodon*, *Pleuronectes*.
VII.	——— Mammiaux,	*Acipenser*, *Lophius*, *Diodon*, *Raia*, *Squalus*.

The families, or "sub-orders" as they are called, placed under each of these "orders," will be best understood by the following table. They amount to four in each; and these, again, have each four "genera." We do not, however, enumerate the whole of the latter.

Order I.—Poissons Zoophytes.

Sub-orders: —		
1. Murena.	3. Cultriformes, including Trichiurus, and Leptocephalus.	4. Cepola.
2. Anguilla.		

Order II.—Poissons Vers.

Sub-orders: —		
1. Lotes, including Blennius, Phycis, Gadius, &c.	2. "Kleques."	4. Gasterosteus, Centronotus, &c.
	3. Scomber.	

Order III.—Poissons Insectes.

Sub orders: —		
1. Perches.	3. Labroïdes, including Labrus, Sparus, Ophiocephalus, &c.	4. Dorades, as Mullus, Scarus, &c.
2. Gymnocephalus, Anthias, &c.		

Order IV.—Poissons Poissons.

Sub-orders: —		
1. Mugiloïdes, as Mugil, Exocetus, &c.	2. Dactyles.	4. Cyprinus, including also Atherina, Argentina, &c.
	3. Clupea (*Linn.*).	

Order V.—Poissons Reptiles.

Sub-orders: —		
1. Cobites, Anableps, &c.	2. Silurus (*Linn.*).	4. Esox, Elops, &c.
	3. Salmo, including Serrasalmo.	

Order VI.—Poissons Oiseaux.

Sub-orders: —		
1. Callionymus, Uranoscopus, &c.	3. Pleuronectes, Zeus, Chætodon, Stomateus.	4. Centriscus, Fistularia, Stylephorus.
2. Gobius, Cottus, Scorpina, Trigla.		

Order VII.—Poissons Mammaux.

Sub-orders : —		
1. Myxine, Petromyzon, Syngnathus, and Pegasus.	2. "Morques," including Cyclopterus, Balistes, and the rest of the branchiostegous fishes.	3. "Chirques," as the genera Acipenser, Ziphias, &c. 4. Squalus, Raia, Chimera, and Lophius.

But, as our author soon after discovered that there were not seven primary divisions in the animal kingdom, he abandoned his second system, and formed another, in which the number four should predominate. In his third arrangement, therefore, M. Oken makes four orders; four sub-orders, supposed to represent the orders; and each of these sub-orders is again composed of four genera. The result of all this will be sufficiently seen in the following table:—

Order I.—Poissons Poissons.

This order includes, among others, the genera—

Murena.	Trichiurus.	Gymnotus.
Gymnotus.	Leptocephalus.	Anarrhicas.
Ophidium.	Cepola.	Xiphias.
Ammodytes.		

Order II.—Poissons Reptiles.

Composed chiefly of the genera —

Gadus.	Cottus.	Stomateus.
Echineis.	Gobius.	Cobites.
Gasterosteus.	Cyclopterus.	Silurus.
Scomber.	Pleuronectes.	Salmo.
Callionymus.	Zeus.	Esox.
Uranoscopus.	Chætodon.	

Order III.—Poissons Oiseaux.

Scorpæna.	Perca.	Mugil.
Trigla.	Mullus.	Clupea.
Polynemus.	Labrus.	Atherina.
Exocœtus.	Sparus.	Argentina.
Sciæna.	Coryphæna.	

Order IV.—Poissons Mammaux.

Centriscus.	Tetraodon.	Lophius.
Fistularia.	Pegassus.	Myxene.
Stylephorus.	Acipenser.	Petromyzon.
Sygnathus.	Spatularia.	Raia.
Mormyrus.	Chimera.	Squalus.
Balistes.		

Finally, our author, abandoning *four* as the regulating number of his groups, adopts that of *five*, probably

from his illustrious countryman Fries. He seems to imagine, however, that because the number five holds good in the primary divisions of structure in the animal and vegetable kingdoms, it should equally do so in every thing; and he accordingly constructs a fourth system, founded on the organs of sense in these obscurely known creatures. This fourth system, M. Cuvier says, was published in Paris in 1822; but as we have it not at present to refer to, we shall transcribe the following table, from that given in the *Hist. Nat. des Poissons*, tom. i. p. 234.

Order I.—Poissons Germiers.

*Apterichte.**	Lophius.	Pleuronectes.
Sphagebranchus.	Gymnetus.	Echineis.
Synbranchus.	*Régalec.*	Platycephalus.
Muræna.	Cepola.	*Macroure.*
Anguilla.	Trachypterus.	Phycis.
Gymnotus.	Gymnogaster.	Gadus.
Ophidium.	Stylephorus.	Centronatus.
Leptocephalus.	*Lépidope.*	Blennius.
Ammodytes.	Trichiurus.	Anarhichas.

Order II.—Poissons Sexiers.

Gobius.	Chætodon.	*Otolithe.*
Periopthalme.	Stromateus.	Sciæna.
Eléotris.	*Eques.*	Perca.
Coméphore.	*Vomer.*	Cichla.
Trichionate.	Zeus.	*Serran.*
Callionymus.	Coryphæna.	Dentex.
Trichiurus.	Rhinchobdella.	Labrus.
Trigla.	Gasterosteus.	Scarus.
Lépisacanthe.	Scomber.	Sparus.

Order III.—Poissons Entrailliers.

Cobites.	Atherina.	Salmo.
Anableps.	Sphyræne.	Mullus.
Pœcilie.	*Polyptere.*	Mugil.
Pimelodus.	Erythrinus.	Clupea.
Maloptérure.	*Lepisostee.*	Elops.
Silurus.	Esox.	Exocetus.
Doras.	Sternoptyx.	Gonorynchus.
Heterobranchus.	Gasteropelicus.	Cyprinus.
Cataphractus.		

* The generic names printed in Italics are vernacular, and not used in this volume. What these French names mean, M. Cuvier has not explained.

Order IV.—Poissons Carniers.

Lepadogaster.	Syngnathus.	Ostracion.
Cycloptera.	*Solénostome.*	Tetraodon.
Uranoscopus.	Pegasus.	Diodon.
Cottus.	Fistularia.	Orthagoriscus.
Batrachus.	Aulostoma.	Platystacus.
Tæniánotus.	Centriscus.	Loricaria.
Synancée.	*Amphisile.*	Lepidoleprus.
Scorpinus.	Mormyrus.	Polyodon.
Malthée.	Balistes.	Acipenser.
Antennaire.	Triacanthus.	Xiphias.
Lophius.		

Order V.—Poissons Sensiers.

Muræna.	Petromyzon.	Squalus.
Chimæra.	Raia.	

(83.) The first circumstance that strikes the naturalist on inspecting these systems, is the different plans upon which they are constructed, and the separation they effect, more or less, between groups which all other naturalists agree in thinking are closely and intimately united. Thus the genus *Doras* of Lacepede is so closely connected to that of *Loricaria*, that it is almost impossible to determine where one ends and the other begins; and yet in the last table of these systems we find they are placed in two different orders. On the other hand, the genera *Acipenser* and *Xiphias* are arranged close to each other, without possessing, so far as we can discover, any one indication of affinity. The merits of every natural system can alone be judged of when the principles it sets out upon are worked out in detail: this done, the materials are before us for forming a correct judgment, whether the series appears to be that of nature or of man. We quite agree with M. Oken, in thinking that the primary orders of fish represent those of vertebrated animals; and every allowance should be made for the imperfect labours of all who endeavour to establish this most important law. But we must confess our inability to make out what are M. Oken's views on this subject; and not being able to comprehend, we have not adopted them.

(84.) And now, having thus far proceeded in what relates to ichthyology in general, we must attempt to establish, in some degree, those primary laws of the

natural system we have ventured to announce. If we were to be guided by the high authority of deservedly great names, rather than by our own impressions of what are the true affinities of nature, we should be equally authorised and encouraged in making this attempt. The is an authority now reigning over this department of zoology, as omnipotent, perhaps, as that which Linnæus once exercised over all branches of natural history; — a zoologist whose superior genius every one must acknowledge, and whose materials for study and reflection, during a long and brilliant career, were almost boundless. We have laboured for the last fifteen years to dispel the illusive idea, that natural affinities could be expressed by a simple series; and that all such exhibitions of nature, however useful, were merely artificial combinations. Now if those few who still doubt on this subject, required such an authority as we have intimated to decide their wavering opinion, such a one exists, and will be found in the learned author of the system we have just surveyed, — the illustrious Cuvier. This extraordinary man, as if to bequeath to us the result of all his varied and profound experience, thus concludes his preliminary observations upon fishes in general, and they deserve from all the most profound attention. In speaking of the cartilaginous order, he thus expresses himself *: — "It is chiefly in these that the futility of classing beings in a single series is visible; several of its genera, the rays and the sharks among others, are considerably above common fish, by the complicated nature of their organs of sense and of generation; these latter being more developed, in some respects, than those even of birds: yet other genera, which are approximated by evident transitions, such as the lampreys and *Ammocœtes*, become so simplified, that they have been regarded as forming a passage to articulated worms; for the latter certainly do not possess a skeleton, and their muscular apparatus is attached to membranous and tendinous supports." — "Let it,

* Règ Anim. Griff. Cuv. p. 22.

therefore, never be supposed, that because one genus, or one family, is placed before another, we consider it more perfect or superior to the others in the system of beings; — he alone could build up such a pretension, who would attempt to place animal nature on a single line. Such a project we have long since renounced, *as one of the most false that can be entertained in natural history.*" — "True system," he again observes, "sees each being in the middle of all the others, and shows all the radiations that link it, more or less intimately, in the vast web of organic nature; and thus alone we acquire enlarged ideas, worthy of that nature and of nature's God; but ten or twenty of these radiations will be often insufficient to express these multifarious relations." Nothing can be more in unison with all that has been urged on the "multifarious relations" of natural objects than this; and no authority can bring more weight to the opinion than this of Cuvier's. True it is, that this conclusion was arrived at by the celebrated Lamarck more than twenty years ago, and that it has long been acted upon by a few of the greatest naturalists now living. Nevertheless, the tardy admission of M. Cuvier to the impossibility of naturally arranging objects in a single series, is even more valuable than if it had come sooner: the very delay shows us that, in truly great minds, truth will finally triumph over early imbibed prejudice, and, although not acted upon, it will yet be acknowledged. If, therefore, we make some attempt, in the following pages, to explain and reconcile these "multifarious relations," and abandon altogether the trammels of an artificial system, the very essence of which is to place fishes in a single series, we do nothing more than follow up the theoretical idea of Cuvier; — a course, however, which imposes the absolute necessity of abandoning all those parts of his arrangement which interfere with the exposition of those "multifarious relations" he speaks of, yet makes no effort to explain on any general principles. To attempt to do this, however, in *all* the groups, would be mani-

festly impossible; and yet, on the other hand, if only one, however small, can be sufficiently analysed to establish what has been advanced on natural arrangement, philosophy teaches us to conclude that similar results would attend the analysis of all others. No other conclusion, in short, can be arrived at, whether by inductive philosophy or common sense.

CHAP. V.

ON THE NATURAL ARRANGEMENT OF FISHES, THE PRIMARY TYPES OF FORM, AND THE ANALOGIES THEY PRESENT TO OTHER CLASSES OF ANIMALS.

(85.) It is manifest to every naturalist, that the most perfectly organised groups, in the great class before us, are composed, as M. Cuvier has truly said, of the osseous fishes, or those whose skeletons are of solid bone. This being their most characteristic mark, it follows, that although osseous fishes (less perfectly organised in every other respect) may be found in other orders which approach these, yet, that none with a cartilaginous skeleton can naturally belong to this most typical division. Now this great assemblage, like those of all others equally typical in the animal kingdom, resolves itself into two groups — the one composed of such as have the rays of the dorsal fins more or less spinous, the other of such as have them soft or articulated. These groups were long ago perceived and defined by the old ichthyologists; and if any authority were necessary to sanction our belief that they are truly natural, we cannot cite a higher than Cuvier. The osseous skeleton, however, although the paramount, is not the only character possessed in common by these two groups. The ventral fins, which are analogous to the

feet of birds and quadrupeds, are almost always present; and the gill-covers are not only moveable, but the branchial aperture is fully developed — in other words, it does not assume the form of a simple slit or spiracle, as in the eels and rays. Here, then, we find the three chief characters of osseous fishes; the first absolute, the two next less so: and it may safely be asserted, that every fish which possesses two out of these distinctions, finds its natural place in the spiny or the soft-rayed divisions. These we regard, like our predecessors, as the two most typical orders of the whole class. We shall now enumerate their characters somewhat more in detail.

(86.) The ACANTHOPTERYGES have the anterior rays of the dorsal fin simple, rigid, and acute; the remainder being branched and articulated; or, if there are two dorsals, the first is entirely composed of spinous rays. We are now, as in the following definitions, speaking of the pre-eminently typical examples; the exceptions will be noticed afterwards. The anal fin is also usually furnished with both sorts of rays, and the membrane is never fleshy. The branchial aperture is large; the bones of the operculum fully developed, and frequently spinous or serrated; the eyes large and lateral; the body ovate or oblong; the ventral fins placed near the pectoral; the scales hard and shining, ornamented with beautiful colours, or richly silvered. They are almost all marine fish, and are more constructed for long continued motion. The aberrant families of this immense order, which includes more than one half of all the fish yet discovered, presents us with several deviations. Some of the blennies are viviparous; and the simple rays of their dorsal fins are sometimes soft; so also are those of the *Ophicephali*. In the *Gymetres*, the ventral fins are occasionally wanting; but the branchial aperture is large: the fins are fleshy in the blennies, and scaly in the chætodons.

(87.) The MALACOPTERYGES, or soft-rayed order, is less numerous than the last, and are so much diversified,

that it is somewhat difficult to find any more certain indication than that presented by their fins: the ventral fin, however, is always present; and the branchial aperture, with one or two exceptions, is unconfined. We thus get three characters; one of which separates this order from the last, another detaches it from the next, and the osseous skeleton from all other divisions. Their organisation, as fishes, appears less perfect than the more typical group; for it is among these we find all the ground fish, — those which are restricted to fresh waters, and such as lie in wait for their prey. In this order, also, we have a small group of viviparous fish, analogous to the blennies in the last. The salmons, pike, herrings, cods, carps, and flat fish, have been justly included in this order, which, in regard to the subsistence it furnishes to man, becomes the most important of all others.

(88.) In the next order, the typical structure begins to disappear, and is finally lost. The skeleton, in some, is still osseous; but in many others is sub-cartilaginous; and even finally becomes membranaceous: the fins, which represent the feet, entirely disappear: the branchial aperture assumes the form of a slit, and is termed a spiracle: the shape is long, and like that of a serpent: the dorsal, anal, and caudal fins, when all are present, are generally united: the body is slimy and naked; or the scales are very minute, and imbedded in the cuticle. The reader cannot fail to recognise, in this description, the essential characters of the eels, lampreys, and other similarly formed families, which have as much the outward aspect of serpents as of fish. To this order we retain the original name of Apodes bestowed upon it by Linnæus.

(89.) Having entirely quitted the osseous structure of bone in the last tribe, we next come to such families as have their skeleton fibro-cartilaginous: these, also, breathe by a spiracle; the operculum being either obsolete, or entirely concealed beneath the common skin. They differ, however, materially from the last, by pos-

sessing ventral fins, and by the following additional peculiarities: — the body is thick, very short, heavy, and often, as it were, deformed; the ventral fins are placed upon a peduncle, so that they may be used, in some degree, as feet, enabling the animal to crawl on the ground; the eyes are small, and placed nearly vertically; the mouth opens in the same direction, and has the under jaw longest: in the most typical family, the body is soft; but in the sub-typical, it is either covered with osseous plates soldered together, or with acute prickles: the ribs are almost always wanting; and they are the only fishes which have the anatomical character of the maxillary bone and the palatine, arch inserted in the cranium. Adopting Cuvier's name for these fish, rather than that of Linnæus, which was founded in error, we term this order the PLECTOGNATHES, or cheloniform fishes.

(90.) The fifth and last primary group consists of those truly cartilaginous families which have the fins and mouth of ordinary fishes, but who breathe by one or more spiracles: the mouth is placed beneath the snout, which is very broad and projecting; the major part are viviparous; and the body is smooth, or, at least, destitute of true scales. The sharks and rays are the best known, and are the most typical of these fish, which, as indicating their typical character, we propose to call the CARTILAGINES.

(91.) That there is every reason to believe these primary divisions of the class are founded in nature, will be apparent from their accordance to the divisions of the same rank that have been generally adopted by the most eminent zoologists. Without attempting, in our present rapid course, to show in what manner they blend into each other and form one great circle, we shall at once proceed to compare them in the order in which they have been noticed, with other groups better authenticated, or rather, we should say, more familiarly known to naturalists. If we are successful in this effort to establish a uniformity of analogical relations

between each and all of such as we may select for this purpose, the circular affinities of the whole will be sufficiently established by anology ; whether we are acquainted, or not, with the precise links that connect the several portions. Our main object, however, is to adduce further proofs of the proposition contained in our early volume of this series, namely, that all animals could be referred to certain primary types of form. It will therefore be advisable, in this place, briefly to recapitulate what was then said, that the naturalist may judge how far the characters there given accord with those by which we have defined the primary types of fishes.

(92.) In the first place, we have said that the most perfectly typical individuals of every natural group are those which exhibit the highest development of those characters by which the group, *as a whole*, is distinguished ; or, in other words, " they are endowed with the greatest number of perfections, and capable of performing to the greatest extent the functions which peculiarly characterise their respective circles." This pre-eminent perfection shows itself, also, in nearly all such types as are of this primary rank. " This is apparent in the order *Quadrumana* among beasts, and in that of *Insessores* among birds ;" both of which are the most perfect, and by far the largest, groups in their respective circles. Among the *Annulosa*, again, the *Ptilota*, or winged insects, are probably ten times more numerous than all other annulose groups put together. In tracing this peculiarity in the typical groups of lower divisions, we find it also very prevalent ; and even in looking to sub-families, or even genera, we find that the genus *Picus*, *Sylvicola*, *Sylvia*, among birds, and that of the restricted sub-genus *Scarabæus* (MacL.) among insects, are all remarkably abundant in individuals, when compared with the remaining contents of their respective circles." Every ichthyologist will perceive that the foregoing observations are as applicable to the order of Acanthopteryges among fish, as if they had been expressly written to distinguish them

from all the others. We can therefore have no hesitation in admitting the conclusion which Cuvier arrived at by analysis, — that this immense group contains the most perfect fishes in existence.

(93.) "Sub-typical groups, as the name implies, are a degree lower in organisation than the last, and thus exhibit an intermediate character between typical and aberrant divisions." This, also, is precisely the nature of the *Malacopteryges*, or soft-rayed fishes: they only yield to the last in the perfection of their structure. "The numerical contents of sub-typical groups are almost universally less than in those which are typical." The truth of this remark is exemplified in the present instance: the number of the soft-finned osseous fishes is probably more than two thirds less than that of the typical group, to which they are evidently inferior in their general structure and in their power of swimming.

(94.) "The NATATORIAL or AQUATIC type of nature, as seen in quadrupeds, birds, and reptiles, are more especially inhabitants of the waters. They possess many and striking peculiarities, modified, indeed, in the most astonishing manner, but more conspicuous, perhaps, throughout all natural groups, than any of those belonging to other types." They are chiefly remarkable for their enormous bulk, the disproportionate size of their head, and the absence or very slight development of their feet. These aquatic characters are exemplified in the *Radiata* in the animal circle; in the class of fishes among *Vertebrata;* in the *Cetæ,* or whales, among the *Mammalia;* and in the *Natatores* among birds. "As we approach the more perfectly organised animals, we see the development of another singular feature — namely, a very large, thick, and obtuse head, furnished with jaws generally capable of great expansion, and terminated by a blunt or truncated muzzle. As fishes constitute the pre-eminent natatorial type of vertebrated animals, so we find that such groups as represent them in other circles of the *Vertebrata* have the feet transformed, as it were, into fins. How beautifully is this exemplified in

whales (forming the natatorial order of the *Mammalia*) ; the swimming order of birds ; and the *Sauri*, or aquatic reptiles ! As to the economy of aquatic types, we have already premised that they are almost entirely carnivorous. In those that belong to quadrupeds and birds, the food is seized by the mouth alone ; the feet being slightly, and often not at all, developed : and all such as do not wander in search of their prey, dart upon it from a fixed station." This is the substance of what was formerly advanced regarding the aquatic types of all animals, and we are now to determine whether the cartilaginous order of fishes does not accord with this theoretical description. Independent of the nature of their bones, they can be immediately recognised from all other fish by the muzzle being so enlarged and produced beyond the jaws as to alter the position of the mouth, which is actually placed beneath the head — not, as in all other fishes, at its termination. The sharks, no less than the rays, are the most gigantic monsters among fish ; and that they are eminently carnivorous is unfortunately too true, since the first are declared enemies to the human race. The great size of the head observed in the aquatic *Mammalia* is not equally conspicuous in the same type among fish, although none have their head larger in proportion to their body than these ; and such is the peculiar shape of the ray, that they seem, like their prototypes the *Crustacea*, to have the head confounded with the thorax and body, so as to give the impression that all three parts were united in order to form an enormous head. The fishes of this family, which we place at the head of the *Cartilagines*, seem also to possess the habit of natatorial birds, in lying in wait for their prey, and darting upon it from a fixed station ; while their viviparous nature is at once explained, when we recollect that these creatures effect the passage between fishes and aquatic *Mammalia*. There can be no doubt, in short, that in the CARTILAGINES we have an exemplification of the natatorial type.

(95.) The type which succeeds the last is the most aberrant division of every circular group. On a former occasion we have stated that one of its most prevalent characters is that of having the mouth very small, or otherwise but slightly developed; and because all sucking animals seem to belong to this type, we formerly called it the *suctorial:* but such a function, in the present class, has not been clearly made out; and, as we have already shown it is represented among reptiles by the tortoises, we shall designate it by the same name there employed, and here, also, call it the *cheloniform* type. This, as was formerly mentioned, is the same as the *grallatorial* type among birds, the *gliriform* among quadrupeds, the *onisciform* or *vermiform* among insects. The most prevalent distinctions of this type, besides the smallness of the mouth, and the absence of true teeth, may be thus concisely stated and illustrated. 1. The general structure is always more dissimilar than any other from the pre-eminent type; they are, consequently, the most imperfectly developed of their own circle. 2. The jaws, or muzzle, or mandibles, are often turned upwards, the lower being longer than the upper: this we see in the Brazilian racoons (*Nasua*); while the avosets, and other grallatorial types, present the same unusual character; and these are the smallest mouthed birds in creation. 3. The eyes are always particularly small, as in the mole, and other gliriform quadrupeds; and in the *Trochilidæ*, *Tringidæ*, and other grallatorial birds: sometimes, indeed, in the aberrant *Vertebrata*, they are even wanting, as in *Myxine*, among fish, and nearly so in *Cœcilia* in the class of reptiles: the situation of the eyes, in all these groups, is likewise very peculiar; they are placed at a distance from the mouth, and very far back upon the head, towards the crown, and thus approximate. This is very observable among the tenuirostral and grallatorial types of birds; and we find the same in the genera *Chironectes*, *Uranoscopus*, and similarly formed fish, of which numerous examples may be cited. But perhaps there is no character of this

type more widely diffused among nearly all the classes of the animal kingdom, than that of the body being mailed, or protected, as in the chelonian reptiles, by bony plates, either united or articulated at their sutures, or lying over each other in the manner of scales. We have already cited numerous instances of this structure in the animal kingdom ; nor is it more conspicuous in the chelonian reptiles than in the cheloniform fishes : the family of the *Balistidæ*, in short, is as complete a prototype of the tortoises, the hedgehogs, the scaly anteaters, the porcupines, and other spined gliriform quadrupeds, as it is possible to conceive. Our surprise is that such resemblances should exist where the nature of the animals are so different. Again, the smallest and most imperfectly formed mouths, destitute of true teeth, are to be found among the PLECTOGNATHES, or cheloniform fishes, which thus became the most aberrant type in the great circle of PISCES.

(96.) There is still a fifth primary form in the animal kingdom, which has been designated the Rasorial type in ornithology, and the Unguiculate among quadrupeds. The characters by which this form may be recognised, among the animals just named, have been already so fully explained, that they need only to be touched upon in this place. In the more organised or warm-blooded *Vertebrata*, great strength of foot, the faculty of climbing, with a facility and aptitude for domestication, are among the most prominent peculiarities observable in this type ; but none of these can be expected in fish. This is the type, however, which is so remarkable for the great development of the tail ; for, if we went through the whole class of birds, and selected those, beginning with the peacock, wherein the tail was most conspicuous, either for its size, its length, its singularity, or for the beauty of its colours, we should unknowingly fix upon those birds which analysis has demonstrated to be rasorial types. The same results would attend a similar selection of quadrupeds, and of winged insects. All these, collectively, furnish many hundred proofs by

which the uniformity of this structure is preserved. We can now add to these proofs others, equally strong, presented by the reptiles and the fish. A great and peculiar development of the tail pervades the whole of the order Apodes, and of all other groups by which it is represented; so that, by designating this type, when speaking of fishes, as the *anguilliform*, instead of the *rasorial*, the reader will immediately be reminded of the eel-shaped form, which is its chief characteristic. By the tail, we do not, of course, mean the caudal fin; for that, in the fishes we are now speaking of, is usually very small; and, among several, it is sometimes wanting. The true tail of a fish, strictly speaking, commences with the termination of the stomach; the length of the latter being manifested, externally, by the situation of the vent. The abdomen of the eels is so unusually short, as not to equal one fourth the length of the tail; and this structure is just as prevalent in groups which represent the apodal order as in the order itself. Thus, although there seems but one character of the rasorial type of birds to be traced also in that of fishes, yet it is the principal one, and it is so universally prevalent, as to render the presence of others unnecessary to detect the analogy. The only instance yet ascertained of the scansorial power being possessed by fish, is that of the *Perca scandens*, which is said to climb banks and aquatic plants by using its pectoral spines as feet.

(97.) We shall now state a few of the modifications under which the anguilliform type appears in such groups as *represent*, without belonging to, the apodal order; all being distinguished, as just observed, by having the abdomen much shorter than the tail. In the eels, the body is cylindrical; but in many other analogous families it is compressed, and that to such an extent, as to have given rise to Cuvier's expressive name of riband-fish. The genera *Cepola*, *Leptocephalus*, *Ophidium*, &c. are good illustrations of this structure; not to mention such extraordinary forms as the *Gymnocephali*

of Bloch. The three fins of the tail, that is, the hinder dorsal, the caudal, and the anal, if not united, as in *Cepola, Ophidium, Plotosus, Anarhichas,* &c. are only separated by a small interval, as in *Physis, Merlangus, Blennius,* &c.; or the ventral fin only is excessively long, as in all the genera and sub-genera of the anguilliform division of the *Siluridæ*. In other genera, the dorsal and caudal fins are obsolete; but the anal extends the entire length of the tail, which terminates in a point. So far as our analysis has extended, it seems that all these are but modifications of the anguilliform structure. The ventral fins, which are universally absent among the true *Apodes,* are sometimes wanting, also, in their representatives, as in *Ophidium, Anarhichas, Ammodytes,* &c.: usually, however, their slight development marks the type we are now speaking of; thus, in the two families of the *Blennidæ* and the *Gadidæ,* the typical genera have their fins composed only of two rays, or, when the others are present, they merely exist in a rudimentary state. The scales, again, frequently present a peculiar character: when present, they are very small, often scarcely perceptible, and appear to be inserted, as in the eels, beneath the cuticle: this is seen in most of the *Gadidæ;* while in other anguilliform types, like the *Blennidæ,* the body is slimy and naked, either covered with an opaque skin, or semi-transparent. The snout is always short and obtuse, the mouth not extensible, and the teeth either very small or none. Nearly the only mailed genus that possesses the anguilliform shape is *Polypterus;* and this, as we suspect, may probably belong to the order *Plectognathes.*

(98.) Having now stated some of the most prevalent analogies between the primary types and divisions of fishes, and those of the warm-blooded *Vertebrata,* we may exhibit the results in a more compact form by placing these groups in three columns; and it will then be more distinctly seen in what way each is related to the other by analogy.

Orders of *Fishes*.	*Analogies*.	Orders of *Birds*.	Orders of *Quadrupeds*.
ACANTHOPTERYGES.	Typical.	INSESSORES.	QUADRUMANA.
MALACOPTERYGES.	Sub-typical	RAPTORES.	FERÆ.
CARTILAGINES.	Snout broad, depressed.	NATATORES.	CETÆ.
PLECTOGNATHES.	Eyes small, placed far back towards the crown.	GRALLATORES.	GLIRES.
APODES.	Tail very long.	RASORES.	UNGULATA.

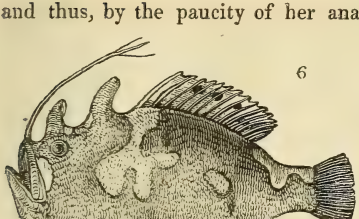
We were at first perplexed to discover how it was that the *Malacopteryges*, by being the sub-typical order, should represent the *Raptores* and the *Feræ;* because these fishes, so far from being pre-eminently carnivorous, comprehend the greater part of such as habitually feed upon vegetables; nor can this apparent contradiction be explained so readily as we could wish, unless by looking to the nature of the whole group. Now, the class of *Pisces* is that aberrant division of the *Vertebrata* which represents the aquatic or fissirostral type of vertebrated animals: this type, therefore, being eminently carnivorous, the animals which represent it, in its greatest perfection, must equally be so: and thus we have an additional verification of M. Cuvier's opinion, that the *Acanthopteryges* are the most perfect of fishes; while the *Malacopteryges*, which are next in affinity, become the next in analogy, and are, therefore, the sub-typical. This view of the question is confirmed on looking to the analogies of other aberrant circles. If we take, for instance, the scansorial birds, which form an aberrant tribe in the circle of the *Insessores*, just as does the class of fish in that of the *Vertebrata*, we find the analogies reversed precisely in the same way. Of the two typical families, the woodpeckers are the most carnivorous, although they are the pre-eminent type; while the parrots, which are the sub-typical, are entirely frugivorous. Those naturalists, who may be interested in this question, will remember how often we have adverted to it on former occasions; and we only again touch upon it here, to show that, however contradictory our second analogy in the foregoing table may at first appear, it is not dif-

ficult to be explained in no unsatisfactory manner. The other three analogies, having already been enlarged upon, require no further elucidation, but may be left to speak for themselves.

(99.) Before proceeding further in this inquiry, we shall here introduce a few observations upon the nature of analogies in general, which have only been glanced at in our former volumes; the more so, because, upon further reflection, some considerations have arisen which seem to us of much importance. It has not been—although it may be—objected to these tables of analogies, that the resemblance between two groups, supposed to represent each other, is usually confined to two, and often to one, analogical character only; while, in all other points of structure, there is a marked dissimilarity. This objection, upon a first view, seems not easily surmounted, because it may be further urged —If these two groups really represent each other, why are they not more alike? Why are we so frequently obliged to labour and search for the purpose of finding a single point of resemblance, which, after all, is sometimes so trivial, and depends on a modification of structure so secondary, that no great importance can be attached to it? To this we should reply, that the importance of a character is by no means to be measured by mere individual or preconceived opinions, but by its constancy in certain groups, whereby affinities or analogies may be detected. And in answer to the main objection, we maintain that this paucity of mutual or common characters, so far from being a stumbling-block, is both inevitable and essential to our theory. Did two analogous groups present such strong resemblances, in most of their characters, that every one would immediately confess the likeness, there would not be a hundredth part of that variety in nature which actually exists. This will be apparent to the reader, when he remembers, that, on the principle of universal representation which we now assume, every group shows an analogy, direct or in-

direct, near or remote, to many hundred others: it is, therefore, absolutely impossible for all these similitudes to be so clear as to silence gainsayers, or even to strike, at first sight, the more experienced naturalist, who often can only estimate the value of the analogy between two remote groups, by tracing these analogies through a series of intervening forms. The innumerable modifications of the same structure which we see in nature, accomplishes two objects: they excite our wonder and admiration of the Infinite Mind whose fiat has produced them; and they enable us, though often dimly, to trace, in one or two characters, a symbolical relationship between a great number of groups, quite different in all other respects. But, perhaps, an example will best explain our meaning. No analogies can well be stronger than those between the chelonian reptiles and the cheloniform fishes, forming our present order *Plectognathes:* but then, if *all* the fishes in this latter group were cased, in the same way, in hard plates—if they *all* had very small mouths, the sharp and crenated jaws performing the office of teeth—if they *all* were eminently aquatic—and, lastly, if *all* their pectoral fins were formed as in ordinary fishes—what possible characters would be left by which to indicate their analogy also to the *Amphibia*, or frogs, which are as truly and confessedly analogous to the tortoises, as the tortoises are to the cheloniform fishes? No such resemblances, that we know of, would remain, except their imperfect skeleton; or none, at least, which would strike an ordinary observer; and we should thus have no apparent mark by which to conjecture the relationship. But Nature has provided against this: has created such a diversity in the order *Plectognathes*, that, while one division immediately reminds us of the chelonian reptiles, another is an equally strong representation of the amphibious frogs. The *Lophius picta* of Shaw (*fig.* 6.) will convince the student we are not prone to exaggerate resemblances. We have only to point to the *Chironectidæ* in proof of this latter relation:

and thus, by the paucity of her analogical characters, relative to *one* group only, she is enabled, as it were, to disperse the rest over a number of others, but of which, each — as the inevitable consequence of this rule — can possess only one or two.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(100.) The two comparisons which we shall now institute, illustrate, and will tend to confirm, the above remarks: the first will be between the primary types, or orders of fishes, and those of the entire circle of the *Annulosa;* the second will be between the fishes and the primary groups of the reptiles.

Primary Divisions of *Fishes.*	*Analogies.*	Primary Divisions of *Vertebrata.*
ACANTHOPTERYGES. MALACOPTERYGES.	The most highly organised groups in their respective circles.	QUADRUPEDS. BIRDS.
CARTILAGINES.	Mostly viviparous.	REPTILES.
PLECTOGNATHES.	Semi-aquatic. No true teeth, or scales.	AMPHIBIANS.
APODES.	Posterior limbs or fins small or none.	FISHES.

Whether the two first groups in each of these columns present any absolute points of resemblance in their structure, we know not; but certain it is, that the osseous fishes, as no less an authority than Cuvier maintains, are the most perfect in their own class, just as the warm-blooded *Vertebrata* are in the opposite column. We have already endeavoured to account for the reversion, as it seems, of the analogies in the two typical divisions of this class; for, were it not so, it might almost be thought that, as the organs of locomotion are most developed in birds, and pelagic or acanthopterous fishes, they would be analogous, as in this respect they certainly are: while the ground fishes, or *Malacop-*

teryges, and quadrupeds, where these powers are evidently diminished, would stand opposite to each other. Be this, however, as it may, we had better, perhaps, for the present, leave these groups as they now stand, and proceed to the two next; that is, the cartilaginous fishes and the reptiles. Between these two there is no analogy, however remote, to be discovered in their external shape; and yet, independent of the mode of their production, this is the strongest point in our present proposition, because it rests upon an authority which no one would be disposed to question. M. Cuvier commences his remarks upon the *Chondropteryges*, by observing that "many of the genera approximate to the reptiles in the conformation of the ear and of the genital organs;" and one of our best ichthyologists has expressed a similar opinion.* Having before adverted to the analogy of the typical *Plectognathes* and the amphibious frogs, we may pass on to that by which the apodal order remains to represent the whole class of fishes. Now this may be inferred, if not substantiated, in two ways, negatively or positively: first, it might be safely concluded, that if the four previous analogies are correct, then there can be no doubt about this last, seeing that it embraces the only two groups which yet remain; but we do not rest altogether upon this deduction. The whole class of fishes are remarkable for the smallness of their posterior members, which, in them, are fins: these are almost universally of a much less size than their dorsals, pectorals, ventrals, or caudals. Now, this characteristic is more conspicuous in the *Apodes*, or anguilliform type of fishes, than in any other; because, among them, the ventral fins are altogether wanting. If we wished to trace this character through other orders of animals, we need only look to the aquatic division of the *Mammalia*, and to the natatorial order of birds; both of which have the most imperfect feet of their respective classes: the corre-

* Yarrell's Brit. Fishes, vol. i. p. 40.

sponding type by which all and every of these groups are represented among the reptiles, being the saurian or natatorial order.

(101.) Although we have hitherto invariably refrained from employing, as instruments for reasoning, the contents of circular groups which have not been previously laid before the reader in detail, and in some degree demonstrated, yet, as the class of reptiles is contained in this treatise, and will follow that of the fishes, we shall here, in some measure, anticipate the results of their investigation, by naming the orders into which, as we believe, they are first divided; and this we do for the purpose of showing their relation to those of the present class, each being arranged in two distinct columns.

Orders of *Fishes.*	*Analogies.*	Orders of *Reptiles.*
ACANTHOPTERYGES. MALACOPTERYGES.	The most highly organised of their respective classes.	LACERTES. OPHIDES.
CARTILAGINES.	Size gigantic; snout broad, depressed; head, large.	SAURES.
PLECTOGNATHES.	Body oval, thick, and mailed; sharp jaws in the place of teeth.	CHÆLONIDES.
APODES.	Anterior extremities imperfect or none.	CHÆMELIDES.

Until very lately we have always been impressed with the idea that the ophidian reptiles, or serpents, were the pre-eminent types of the reptiles; because their form is that which seems to be most prevalent in other animals which represent that class; yet, as the pre-eminent type is found invariably to be that which is most highly organised, so it would seem to follow that this rank belongs to the lizards (*Lacertes*) rather than to the serpents. This theoretical conclusion is borne out by the above table, where we find the acanthopterous fish and the lacertine reptiles standing opposite; each being the most highly organised of their own class. The affinity between the lizards and serpents is equally close as that between the two typical orders of fishes; and both are sub-typical. The relationship between the cartilaginous fish and the saurian or aquatic reptiles

(which includes the crocodiles and most of the extinct fossil genera) is very striking: both are the most gigantic and ferocious inhabitants of the water; and, like all types pre-eminently aquatic, they have the head large, the muzzle long and generally broad, the mouth large, and armed with formidable teeth. The close resemblance, again, between the tortoises and the mailed *Plectognathes* require no additional evidence in support of their perfect and beautiful analogy. Lastly, we have apodal fishes, standing opposite to that most singular group of reptiles represented by the chameleon. We shall not here anticipate the reasons subsequently given for placing these scansorial lizards as the representatives of a distinct order; but we may here call the attention of the naturalist to the following resemblances existing between these two groups. The locomotive members of the chameleon assume, indeed, the form of feet, and not of fins; but then they are the least organised feet of all the lizards, and are formed completely on the scansorial model; the toes being in pairs, of which two are placed forward and two backward: the tail, again, as if to make up for this deficiency, is highly developed, not so much in its length, as in the faculty it possesses of being prehensile, so that it can be used, like that of scansorial birds, as a hinder foot or support. Now, the structure of the apodal fishes is singularly analogous to all this: the fins which represent the feet are entirely wanting; while, at the same time, they have invariably the longest tails. The apodal order passes into that of the *Acanthopteryges;* and they are as closely united as the chameleons are to the *Lacertes*, or lizards.

(102.) To pursue these details further appears unnecessary. If we have been successful in determining the primary types of the class now under consideration; and if they truly represent, as here stated, the corresponding types in the other vertebrated animals; it follows that, through these latter, they represent all others contained in our preceding volumes. These comparisons will amply repay the labour of those naturalists

who feel, with ourselves, the inexpressible pleasure of tracing resemblances under innumerable disguises, as if they were employed to conceal the simplicity of a few general laws, by which all the variations in the animal world are regulated.

(103.) It now only remains to bring before the eye, at one glance, all the groups we have touched upon; the affinities being expressed perpendicularly, and the analogies horizontally.

Circle of the Class of PISCES.	Circle of VERTEBRATA.	Circle of REPTILIA.	Circle of BIRDS.	Circle of MAMMALIA.
1. *Acanthopteryges.*	QUADRUPEDS.	*Lacertes.*	*Insessores.*	*Quadrumana.*
2. *Malacopteryges.*	BIRDS.	*Ophides.*	*Raptores.*	*Feræ.*
3. *Cartilagines.*	REPTILES.	*Saures.*	*Natatores.*	*Cetacea.*
4. *Plectognathes.*	AMPHIBIANS.	*Chælonides.*	*Grallatores.*	*Glires.*
5. *Apodes.*	FISH.	*Chæmelides.*	*Rasores.*	*Ungulata.*

One advantage attending this recapitulation, is the facility it gives of embracing, at a single glance, the different degrees of analogy of the whole *Vertebrata:* the sharks, for instance, are thus shown to be representatives of the natatorial birds; an analogy which, if simply stated as an isolated proposition, would certainly appear fanciful and altogether improbable; and yet, when traced through the medium of the aquatic *Mammalia,* or *Cetacea,* and then through the *Ichthyosauri,* and other aquatic reptiles, is at once brought home to the conviction of every unprejudiced mind, even without the high authority of Cuvier. Here, then, we may close our general introduction, and proceed at once into as many details of the several orders as the nature of our work will permit.

CHAP. VI.

ON THE ORDER CARTILAGINES, OR CARTILAGINOUS FISHES.

(104.) The cartilaginous fishes, at the head of which stand the sharks and rays, are well known to be the largest and the most formidable of the whole class. The peculiar structure of their skeleton, which gives rise to their name, admits of these animals continuing to grow as long as they live; the consequence of which is, that as they inhabit the wide ocean, and have few enemies, they are sometimes met with of such an enormous size, that their weight and dimensions are almost incredible. Besides these two families, numerous both in minor divisions and species, we include the sturgeons, the spoon-fish (*Spatularia* of Shaw), and those extraordinary fish, the *Chimærinæ*, or sea-monsters.

(105.) The distinguishing anatomical characters of this order consist in the skeleton or bones being entirely cartilaginous; that is to say, it is not formed of osseous fibres, but the calcareous matter is deposited in small grains, and not by filaments: hence it is that there are no sutures in their skull, which is always composed of a single piece; the usual divisions, however, of the cranium of ordinary fishes may, in these, be readily distinguished by the angles, hollows, and other inequalities on the surface of the cranium. It is remarkable, also, that the moveable articulations in the other orders are here not at all apparent. As an instance of this, it may be mentioned, that a part of the vertebræ of certain rays (*Raia*) are united into a single body; while, in other instances, some of the articulations of the bones of the face, according to Cuvier, disappear. The most apparent anatomical characters of this class is, to want the maxillary and inter-maxillary

bones, or, rather, only to have them in an incipient state, concealed under the skin, while their functions are performed by the bones analogous to the palatine arches. The gelatinous substance, which, in other fish, fills the interstices of the vertebræ, and communicates only from one to the other by a small hole, forms, in many of these fish, a cord, which threads the whole body of the vertebræ, with scarcely any variation in its diameter. *

(106.) The connection of this order of fishes to the reptiles, properly so called, is effected by means of the *Elaniosauri*, or the fossil genera of *Ichthyosaurus*, *Plesiosaurus*, and other swimming lizards of gigantic dimensions, now extinct. M. Cuvier, without being aware of the full value of his observation, confirms our theory in this point, when he declares that "these cartilaginous fishes approach the reptiles by the conformation of their ear and of their generative organs;" while, on the other hand, to prove their affinity to the cetaceous quadrupeds, it has been well observed that these latter "lead us, by a very distinct and natural transition," to fish. "The viviparous sharks, such as the basking shark (*Selache maxima* Cuv.), with their ear more perfectly organised than that of other fishes, and their body destitute of scales, the particular disposition of their fins, and their closed branchiæ, all indicate at what place we are to enter among the fishes upon leaving the cetaceous quadrupeds." † It is curious to see, by the above opinions, how perfectly these two naturalists really agree, at the very time when, from a partial consideration only of their theories, they would appear as opposing the views of each other: both may, indeed, be said to be in part right. M. Cuvier, by depending entirely on his consummate knowledge of comparative anatomy, came to the determination of placing the class of fish immediately after that of reptiles: while Mr. MacLeay, following the simple circle of affinity in the *Vertebrata*,

* Règ. An. 2d ed. tom. ii. p. 376. † Hor. Ent. p. 272.

places the birds after the reptiles, the quadrupeds after the birds, and the fishes after the quadrupeds, without having the least suspicion that, although this series was natural, it possessed *another* property, by which the amphibians, the reptiles, and the fish, formed a primary circle of their own ; and thus reduced the three aberrant divisions into one. The cartilaginous fishes, in short, unite the aberrant divisions of the vertebrated circle into one ; while, at the same time, they open a passage to the quadrupeds by means of the whales, the dolphins, and the porpoises. If the student wishes to comprehend this double affinity, let him compare the figures of the *Ichthyosaurus* with that of a shark, and he will be immediately convinced that no reptile so much resembles a fish as does the *Ichthyosaurus :* again, if he looks to the porpoise, its resemblance to the cartilaginous fish is so peculiarly striking, that he will be not at all surprised at the older naturalists placing them in the same class.

(107.) The views we have taken of the cartilaginous order in other respects are so different from those of M. Cuvier, that we deem it necessary, in this place, to explain our reasons. Although the arrangement of this order in the *Règne Animal* is confessedly artificial, it is liable to much fewer objections than usually attend such methods, because the two typical divisions (the sharks and the rays) are so peculiarly marked, that upon this point there never had been the least difference of opinion. The only objections, therefore, that may be made to his remaining series, regard the aberrant groups. It is quite evident, that if all fishes whose bones are cartilaginous are to be placed in this order, the genera *Leptocephalus*, *Lophius*, *Cyclopterus*, and several others, have as great a claim to be associated with the sharks and rays as *Petromyzon* ; while, if we extend the order to such as have the branchia so hid, that they only present an external slit, the order must be enlarged so as to include the eels and several cognate genera. Both these principles appear equally objectionable ; the

more especially as we should then cast aside all regard for outward form, by which Nature, as it were, stamps the most obvious and tangible affinities of her own groups. The lampreys, indeed, have a second character in common with the sharks and rays; which is, in having more branchial apertures than any of the other eel-like fishes of the order *Apodes:* but when we see, even in the same genus of sharks, that the number of these orifices is by no means constant, and that in the sturgeons and the chimæras, regarded by all writers as true *Cartilagines,* these orifices are only one on each side, as in the *Murænidæ,* it becomes obvious that *number* alone is but an inferior character, and cannot be considered as a primary distinction even of a genus, much less of an order. These considerations are sufficient to excite very strong doubts on the propriety of placing *Petromyzon* in the present order. If we look again to the relations of these two groups, this opinion receives additional strength. The affinity which the cartilaginous fishes bear to the aquatic order of quadrupeds — that is, to the whales and the porpoises — is too well known and acknowledged to be here detailed; while that between the lampreys and the red-blooded worms is no less evident: both these affinities, indeed, have been acknowledged by Cuvier; and it therefore follows as an inevitable consequence, that these two groups of fishes must be kept distinct,—the cartilaginous being placed nearest to the *Mammalia,* while the lampreys are arranged so as to form a passage to the *Annulosa,* by means of the *Annelides,* or red-blooded worms. Cuvier, indeed, well observes that the "lampreys have a skeleton so defective, and such simplicity of organisation, that we might almost arrange them with the worms:" they are, in short, if not "the most imperfect of all vertebrated animals," at least the most imperfect of the entire class of *Pisces.* Excluding, therefore, the *Cyclostomi* Cuv. from this order, we find that the remainder of our author's *Chondropterygii* form a natural group; the primary divisions of which we

shall now endeavour to make out, and subsequently demonstrate.

(108.) Of all the cartilaginous fishes yet discovered, that which seems to make the nearest approach to the osseous orders, is the *Polyodon reticulatus* (*fig.* 7.), a

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most extraordinary fish, about a foot long, found in the Mississippi. It is at once known by the excessive prolongation of the snout, which is very flat and lanceolate, or broadest in the middle, while its length is nearly equal to that of the whole body. The skin is smooth and destitute of scales. The general structure shows an affinity to the sturgeon, close to which it has always been arranged; but it differs from that genus in some important particulars, besides presenting a totally different form. The maxillary and palatal bones, indeed, are united; but the pedicle of the mouth has two articulations. The mouth itself is wide, and is furnished in the upper jaw with a double, and in the lower with a single, row of small, but sharp, curved and serrated teeth. In all these respects, however, we still have the general characters of a cartilaginous fish; but by its other characters we trace its connection to those whose bones are osseous. The spiracle, common to the rest of this order, is so large as to assume the appearance of the branchial aperture of ordinary fishes; for both Lacepede and Cuvier affirm that it extends to the middle of the body. It is covered by a very large, soft, and pointed operculum, which, on being raised, exhibits the gills, consisting of five cartilaginous lamina, with fringed edges, as in the generality of fishes. Like *Acipenser*, there is a large swimming bladder: the intestine is provided with the spiral valve common to this order; but the pancreas, according to Cuvier, exhibits

the commencement of a subdivision into lobes; in other words, makes a departure from the cartilaginous structure, and the nearest approximation yet discovered to the more complicated form observable in all the osseous orders.

(109.) The Sturgeons (STURIONIDÆ) form the next aberrant group, of which, at present, only one genus is known. All the species are distinguished by being defended, as it were, by armour, or, at least, having the body covered by hard bony tubercles. The mouth is small; but instead of teeth it is furnished with a horny prolongation of the jaws, which perform the same office, and are analogous to what we see in the cheloniform fishes. The mouth, however, has this peculiarity,—that, by its possessing a style with three articulations, it has the power of being protruded and retracted at pleasure. The gill-cover is of one oval radiated plate; but the aperture is comparatively small, and its cover, by being edged with a membranaceous border, closes the aperture so accurately as to exclude the air. The food is small fish and worms.

(110.) The common sturgeon (*A. sturio* Linn., *fig.* 8.)

affords that well known delicacy called *Caviar*, which is, in fact, the roe of this fish properly prepared and dried. It is usually inclosed in wax, and in this state is sent to all parts of Europe. Sturgeons grow to a very large size, many having been caught that measured more than twenty feet long. Its form is lengthened and slender; the snout very long in some species; and the mouth, as in nearly all the cartilaginous fishes, placed beneath. Several cirri, or worm-like appendages, are seated beneath the muzzle, and near the mouth: this latter consists of a transverse oval

orifice totally destitute of teeth, but containing a thick and strong tongue; it is bordered, both above and below, by a strong cartilaginous edge or lip, which has the power of retracting and closing at pleasure. The whole body, which is pentagonal, is more or less covered, according to the species, by strong, large, bony tubercles; thus forcibly calling to mind, both in its covering and the construction of its mouth, the toothless quadrupeds (*Edentata*). Sturgeons are natives of the northern European and American seas; they migrate, during the early summer months, into the larger rivers and lakes, and, after depositing their spawn, return again to the sea. The North American sturgeons may almost be called freshwater fishes, since they are rarely taken at any great distance from the shore. In some of the rivers of Virginia they are so numerous, that Pennant affirms 600 have been taken in the space of two days, by merely putting a pole into the water, with a strong hook at the end, and drawing it up again on perceiving that it rubbed against a fish. There are regular sturgeon fisheries, during summer, near Pillau, and in the river Garonne, on the coast of France. Its flesh is described as delicious, both as regards delicacy and firmness. In this country, sturgeons are much more rarely met with than formerly; the largest ever taken, according to Pennant, weighed 460 pounds. The fish, when roasted, is said to resemble veal; but that which we receive from the Baltic and North America is generally pickled. The sturgeon was a fish in high repute among the Greeks and Romans: Pliny informs us it was brought to table with much pomp, and ornamented with flowers; the slaves who carried it being also adorned with garlands, and accompanied by music. A smaller species, called the sterlet (*Acipenser Ruthenus*), found in Russia, is in much higher esteem for the table than the common species. The soup of this fish formed one of the favourite luxuries of that gigantic epicure, prince Potemkin of Russia, who, as Dr. Shaw relates, in seasons when this fish happened to be unusually dear,

was contented to purchase it at a price so extravagant, that a single tureen, forming the mere prelude to his repast, cost him the sum of 300 rubles*; a sum, we may add, which, had it been expended in promoting the happiness of his miserable serfs, might have called down blessings on the head of this worthless sensualist.

(111.) The third division is represented by the CHIMÆRIDÆ, or sea monsters (*fig.* 9.), so called from the fan-

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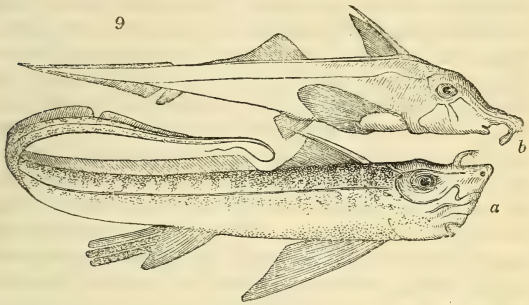

tastic shape of their heads, which are ornamented, if this term may be used, with a singular hoe-shaped appendage tipt with spines, and analogous to a crest, upon their snout: in other respects they have the "closest relation," as it has been well observed, to the sharks; from which, however, they essentially differ, in having a still smaller mouth: the palatine and tympanic bones are merely rudimentary, and suspended to the sides of the muzzle, which is much advanced, while the upper jaw is represented only by the vomer. The *Chimæra borealis* (*fig.* 9. *a*) is the chief of three species, remarkable for the singularity of its appearance, which gives as much the idea of a reptile as of a fish. It grows to three or four feet long. The head is very large and obtuse; but the body terminates gradually into a long and slender filament. In

* Gen. Zool. vol. v. p. 377.

reference to the natural affinities of this extraordinary fish, the head deserves particular attention: it is very large, thick, and rises in the shape of a conical pyramid: at a little distance from the tip of the snout, in the male fish only, is a short upright process, terminating in a fringe; the whole resembling a tuft or crest: the mouth is placed rather beneath, and is small for the size of the fish; it has no true teeth, but the jaws are furnished with broad bony laminæ; and these are notched in the margin, so as to resemble numerous small teeth; while in front, both above and below, stand two large, subtriangular, flattish cutting teeth. We see, in short, the first indication of the plectognathiform structure, and of all those other groups where the teeth are represented by crenated or serrated bony jaws, analogous to the chelonian reptiles. The northern *Chimæra* lives in the deep recesses of the ocean, and is therefore seldom seen to approach the shores, except during breeding time. It is described as a nocturnal fish, chiefly searching for its prey at that season; when it devours the young of the cod, herring, and other similar tribes. Its flesh is particularly coarse and uneatable; but the Norwegians are said to esteem its eggs, which are mixed up with their pastry. Much oil is contained in the liver. The *C. Australis* (*fig. 9. b*) inhabits the Southern Ocean. Having now enumerated the most aberrant forms in this order, we shall proceed at once to those which are more typical.

(112.) The Squalidæ, or sharks, are the most conspicuous and the most perfectly organised of all the cartilaginous fishes. Their forms are often gigantic, and their fierceness and voracity are proverbial: they are the dread and detestation of mariners; and even when dead, their aspect is sufficient to excite fear. These monsters of the deep are nearly all completely carnivorous; and their appetite is so voracious, that they indiscriminately devour whatever living being comes in their way It is a well-authenticated fact, that some of these monsters, at a single bite, have cut a man in

half; and an entire human body is said to have been found, on one occasion, in the stomach. Fortunately, however, very few of those found in our temperate latitudes grow to such a size as to awaken our fears, or commit injury upon our persons; but so soon as we enter the warmer regions, towards the tropics, bathing in the sea becomes a hazardous, and often a dangerous, undertaking. The late sir Brook Watson is well-known to have had his leg amputated by one single bite of a shark, while bathing in the West Indies: and both there, and on the opposite coasts of Africa, the ocean swarms with them. A very few species, however, feed upon animals that are already dead, and even upon marine plants. They all swim with great velocity, and often in vast multitudes, when pursuing shoals of other fish. Our excellent ichthyologist, Mr. Couch, says he has heard of about 20,000 of the picked dog-fish (*Spinax acanthias*), having been taken in a Cornish net, called a sein, at one time; and such is the strength of instinct, that young ones, not six inches long, are found, in company with their parents, following shoals of fish, on which, at that age, they could not prey.*

(113.) The form of all the sharks is lengthened; the body and fins being covered with a hard coriaceous skin, often tuberculated, and sometimes intermixed with spines or plates; but none have been yet found with true scales. The substance called shagreen is no other than the prepared skin of these and other cartilaginous fish, the different degrees of roughness indicating different species. The head is always more or less flattened, generally wider across than the body; and sometimes, as in the hammer-headed sharks, enormously dilated. The snout, more especially, is dilated, and always advances † considerably beyond the mouth, which is thus concealed beneath, and can only be seen, or indeed used, when the fish is turned on one side: this is precisely the case with the rays; and renders it necessary

* Yarrell's Brit. Fishes, vol. ii. p. 401.
† Except in the most aberrant forms.

that both should turn almost upon their backs, in order to seize their prey. The teeth of the shark exhibit, perhaps, the most formidable apparatus for devouring, of any animal in creation. In some species they are so numerous, that, upon opening the mouth, the eye sees nothing but a forest of pointed teeth, any one of which, if detached, would be sufficient to inflict a most severe wound: some of these are for the purpose of seizing, others for tearing; but there are none for grinding, as the food of the shark is always swallowed in an entire state: the only exceptions to this general rule are found in those genera (*Pristis* and *Mustelus*) which form the passage to the rays, and where the teeth are flat, blunt, and tesselated. All the other sharks have pointed teeth, but differently modified in their form; and this diversity, as implying difference of food or habit, deserves much attention. The gill-covers, as already observed, do not open as in ordinary fishes: the branchia, in fact, are completely concealed beneath the skin; yet their number may be judged of by certain oval perforations, placed in a single row on each side, through which the water is emitted in the act of respiration. Let us now proceed to examine this family in more detail.

(114.) To professor Rafinesque* belongs the honour of being the first who ventured to break up the old Linnæan genus *Squalus* into a number of others; to all of which he has attached well-constructed names, and, in most cases, very satisfactory descriptions. This reformation was begun many years before the appearance of the *Règne Animal;* but the name and works of Rafinesque were then so little known, that M. Cuvier was ignorant that nearly all his divisions had been anticipated. As the work wherein these genera were first characterised, is now become scarce, and as Rafinesque's names have the undoubted priority of all others, we shall here lay them before the reader in his own words, more particularly as he describes two or three which still re-

* Caratteri di Alcune Nuovi Generi, &c. Palermo, 1810.

main entirely unknown to all naturalists who have followed him.

1. G. Carcharias. No spiracles: dorsal fins two; anal one: five branchial apertures on each side: tail oblique, unequal.—*Obs.* This genus is the first among the *Squalini*, and contains those species which are the largest and the most voracious. It is strikingly distinguished from the genus *Galeus*, by the absence of spiracles.

2. Dalatias. No spiracles: two dorsal fins, but no anal: five branchial apertures on each side: tail unequal, oblique. This genus differs from the last by wanting the anal fin; and from that of *Squalus* proper, by the absence of spiracles. Teeth flat, long, acute, disposed in a single row on the under jaw, and in two on the upper, where, also, there are others much smaller: eyes round: the branchial apertures are rather large. Two species are described, — *D. sparophagus* and *nocturnus*. The latter has the anterior part of the dorsal fin spined, and the posterior acuminated; the head has numerous pores: habits nocturnal: length seldom above three feet: the teeth are unequal, acute, disposed in various ways: dorsal spine united half way to the fin: branchial apertures narrow. The pores on the head are very remarkable: they are easily seen, although very small; and are round, unequal, and irregularly scattered on each side of the head, from the tip of the snout to above the eyes.

3. Tetroras. No spiracles: two dorsal fins, and one anal: branchial apertures rather large, four on each side: tail unequal, oblique.

4. Isurus. No spiracles: dorsal fins two, the posterior adipose; anal fin one, adipose: branchial apertures five on each side: tail vertical, equally divided, and lunulate. This genus is remarkably distinguished from all others in this order, by the form of its tail,—a form which is not seen in any other, and from which the name is derived.*

* The only species known to our author is described in the following words, where he introduces those other characters which belong to the

5. Cerictius. No spiracles: two dorsal fins; the posterior much larger and bilobed; anal one: branchial apertures five on each side: tail unequal, oblique: head with two bony appendages in the form of horns. — *Obs.* The two appendages, or rather horns, which this genus bears on the head, give it an aspect of great singularity, and readily distinguish it from the next genus.*

6. Alopias. "No spiracles: two dorsal fins; the posterior adipose; the ventral is single, and also adipose: branchial openings five on each side: tail as long as the body, oblique, unequal." Of this one species, *A. macrourus*, is described, which, our author remarks, has some affinity to *Galeus vulpecula*, or *Squalus vulpecula* Linn.; but is distinguished by the absence of spiracles, by its adipose fins, its greater size (12 or 14 feet), &c. The mouth is small; the teeth are minute, acute, flat, and disposed in different ways†; the eyes are large and much sunk.

7. Heptranchias. No spiracle: a single dorsal and anal fin: branchial openings seven on each side: tail unequal, oblique. Our author does not describe, or appear to have seen, the only species he thinks belongs to this genus, which, he says, is the *Squalus cinereus* of Lacepede.

8. Galeus. Spiracles two: two dorsal fins, and one anal: branchial apertures five on each side: tail unequal, oblique. — *Obs.* The greater part of the *Squali* of authors are now placed in this genus, which is distinguished from that of *Squalus* (as restricted by our author) by the presence of an anal fin.

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genus. Isurus *oxyrynchus*. — "Grey above, white beneath: snout very acute: lateral line apparent, and rather curved: base of the tail angulated, and nearly winged on each side: the branchial apertures are very long and narrow: each jaw has three rows of teeth near the palate: eyes small and round: the hinder dorsal opposite the anal. It grows to the length of ten feet, and is called *Pesce-tondo*."

* The only species enumerated of this most extraordinary genus (which seems absolutely unknown to all succeeding writers), is thus described: —

"C. *macrourus*. Above bluish black; beneath white: appendages obtuse, recurved towards the eyes: tail forming one third the total length. This rare fish is called by the Sicilians *Pesce diavolo*, on account of its horns. One was caught off Palermo in March, 1806, which measured eight feet, and weighed six Sicilian cantars."

† "In diversi ordini."

9. Hexanchus. Spiracles two: branchial apertures six on each side: dorsal and anal fin single: tail unequal, oblique.—*Obs.* The lesser number of the branchia, and the presence of spiracles, distinguishes this genus from that of *Heptranchias*, although both have a single dorsal fin. This is founded on the description of the *Squalus griseus* of Lacepede; which, as it is not a native of Sicily, nor appears to have been seen by our author, he does not describe.

10. Etmopterus. Spiracles two, round: dorsal fins two, laciniated—the first armed with a spine, the second nearly opposite to the vent; no anal fin: branchial apertures three on each side: tail unequal, laciniated, oblique: muzzle obtuse: nostrils with appendages: teeth small and acute: eyes oval, and deep sunk. This genus, and the *Squalus squatinus* Linn., have the least number of branchial apertures among the whole of the *Squali*.

(115.) It is much to be regretted, at the present day that some of these genera have not been more fully described: but it is also true that most of these descriptions are sufficient to identify both the genera and the species; and that they are even more precise than those which were in use twenty-five years ago. It is very easy to attempt to reconcile some of these genera with others of their congeners, by attributing inaccuracy to the author; and this has been done, in numerous instances, by Cuvier — with what degree of truth will hereafter appear: but even if we suppose our author may have overlooked some points, and have been mistaken in others, there are, nevertheless, some of these genera whose structure is altogether unique, and too remarkable to be either confounded or misrepresented; among these are *Isurus*, having an equal lunate tail; *Dalatias*, having spiracles, but no anal fin; *Cerictius*, possessing horn-like appendages; and *Etmopterus*, with only three branchial apertures.* Until the existence of such fish

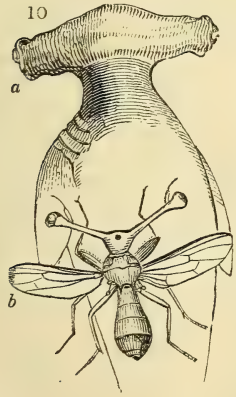
* Upon this alleged fact, M. Cuvier says, "Our author is most probably mistaken, for he describes the *Squalus squatina* of Linnæus as also having but three, whereas it has five." But before we can make up our minds on this subject, it will be necessary to show that there is not a species, also,

is absolutely disproved, we see no reason for considering them as purely imaginary. Professor Rafinesque resided five years in Sicily, and therefore had far better means of discovering its rarer productions than naturalists who have merely staid there for a few months. Some of these genera, we have no scruple, therefore, of adopting, while others may be held in abeyance until they are verified by further observation.

(116.) If we look to the different genera in which authors have divided this family, with a view to determine those which are more typical, and such as are aberrant, we shall have but little hesitation in fixing upon *Pristis* and *Zygæna* as forming two of these; while most authors agree in bringing *Squatina* also into the family: this is in accordance, also, with the views of Cuvier, who has separated the hammer-headed group from all the other sharks, and placed *Pristis* and *Squatina* in the same rank. There yet remains, however, the great bulk of the family under his genus *Squalus:* these are obviously the most typical sharks, and, like all such assemblages, contain two distinct groups or sub-families, which we shall here term the *Squalinæ* and the *Centrinæ;* the first being distinguished by the absence, and the last by the presence, of spiracles. These are small temporal orifices, which, when they exist, are placed immediately behind the eye: their peculiar use is not clearly known, but they must unquestionably perform an important office in the economy of these fishes; because, from their universality in one of these typical groups, and their absence in the other, it would seem that nature intended thus to distinguish them. The two aberrant genera of *Pristis* and *Squa-*

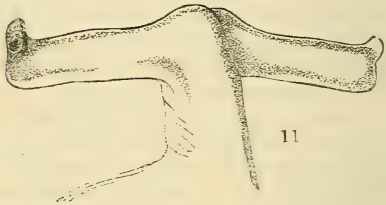
in Sicily, with only three apertures, which Rafinesque has supposed to be the *squatina* of Linnæus, and so described it. Now I think that the existance of such a species is just as probable, if not more so, as that Rafinesque has overlooked two of the spiracles. I can bear testimony to the peculiar tact and unwearied zeal of our author, in detecting species closely allied to each other. I must here again repeat, and the proofs will follow, that not one half of the Sicilian fishes, described by Rafinesque, were known to M. Cuvier, who has not only omitted them in his great work, but thrown discredit on their very existence.

tina contain very few species; and they are so much isolated, when compared with the graduating links of connection seen among the true sharks, that their precise situation in the circle is still open to dispute. We have to regret, also, the same paucity of forms between these aberrant *Squalidæ* and the three aberrant families, or rather types of families, already noticed; so that, whether the true sharks (*Squalidæ*) are directly connected to *Chimæra*, or to *Polyodon*, is a question impossible to be determined at present by simple analysis. It might, indeed, be thought, on a hasty view of the subject, that *Pristis* leads immediately to *Polyodon:* but all authors agree, and we think justly, that this singular fish connects the sharks to the rays; and this will be apparent when we come to describe it. *Squatina*, also, has more the aspect of a ray than of a shark. *Zygænæ*, therefore, is that group of the *Squalidæ* most removed from the *Raidæ;* and it must, consequently, stand at the furthest extremity of its own family,—in other words, at that point which is in the line of passage to *Polyodon*. With this group, therefore, we shall now commence our survey.



(117.) The *Zyganinæ*, or hammer-headed sharks (*fig.* 10. *a*) present, at the first glance, a marked and decided character in the form of the head, which, as their name implies, may be compared to a hammer, the body of the fish representing the handle; in other words, the head is flattened, with the sides so much prolonged that the eyes, which are at the extremities, appear placed on two great peduncles. Cuvier remarks that the animal kingdom presents no

other example of a head so formed; but this is incorrect: the genus *Diopsis* (*b*) among insects, gives us a perfect representation of these hammer-headed sharks: the resemblance, in short, is so striking, as alternately to excite our wonder and our risibility at seeing a fly so like a fish (*fig.* 10.) In other respects, we find the structure in general accordance with the rest of the true sharks. There are no temporal spiracles; but the teeth are strong and acute, crenated on their edges, and placed in three rows. The female is oviviparous. The species are few, and these not well understood. The *Z. malleus* is that which is best known: it inhabits the seas of Southern Europe, and grows to twelve feet long. A second is found in India; and what seems a third is peculiar to the Australian seas. The most typical species, however, yet known, has been recently discovered and described by Dr. Cantor * as the *Z. laticeps* (*fig.* 11.). These



are all typical examples; but the aberrant forms, which have the head more heart-shaped, it will be necessary to place in a distinct genus.

(118.) The second type of the aberrant sub-families is the genus *Pristis*, or saw-fish. This genus has been placed by all writers between the sharks and the rays; and with great truth, for it partakes almost equally of the structure of both — uniting, however, a peculiarity altogether its own. This consists in the

* An acute and most zealous naturalist, whose materials for elucidating the fish, serpents, and mollusca of India are particularly valuable; the drawings and descriptions having been made from the living subjects.

enormous prolongation of the snout (*fig.* 12.), which is straight, flat, and nearly of equal breadth throughout:

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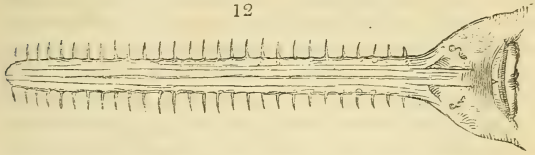


the tip is obtuse; but the sides are armed with a single row of strong acute spines, pointing outwards so as to resemble a very wide-toothed comb.* Cuvier observes, that the anterior sides are sharp or cutting; but this is certainly not the fact in regard to such as we have examined. With this weapon, as it is said, the saw-fish attacks its prey, and even encounters the large *Cetacea*, or whales. The mouth, placed quite beneath the snout, is furnished with small rounded teeth, close together, as in the rays; and, as in that family, the branchial apertures are placed beneath the pectoral fins. It possesses, also†, another character of the rays, in the nasal cartilage already alluded to. On the other hand, its affinity to the sharks is shown in the general elongated form of the body; but more especially by that peculiar character, which distinguishes the *Squalidæ*, of having the pectoral fins totally free and unattached to the head or snout,—a formation, however, which is likewise seen in *Squatina*. Nevertheless, the pectoral fins in *Pristis* are not dilated from the base, as in *Squatina;* and the general structure of this and all the other fins is precisely the same as those of the true sharks. The temporal orifices are large, and placed behind the eye; while the teeth, in the generality of the species, are flat and tesselated; the

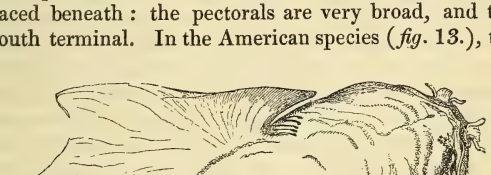
* A species now before us, from Tropical America, has no less than 28 of these teeth on each side the snout; it is probably the *Pristis pectinatus*.

† Mentioned by Drs. Muller and Henle.

mouth and the branchial apertures being placed completely beneath, — the former under the eyes, the latter under the pectoral fin, — so that neither of them can be seen when the fish is laid upon its belly. These fish, of which there are several species, grow to a large size, and appear to be pelagic, or rovers of the ocean. Some inhabit all latitudes, from the coldest to the hottest; but no doubt each species has its peculiar geographic range, although none have yet been found on our own coasts. The common species is said to attack whales much in the same manner as the sword-fish; although it is obvious that the snout, being calculated to cut laterally, and not to thrust, must be used as an offensive weapon, in a very different manner: for this reason, we do not believe the assertion that some writers have made, that the snout of the saw-fish has been found driven into the sides of ships like those of the sword-fish; because any one who looks to this snout, and observes that the end of it is quite blunt, must see such a thing to be altogether impossible. The species often grow to between 18 and 20 feet long, and are chiefly distinguished by the number and form of the tooth-like processes on each side. Klein first made known the singular fact, that in the fœtal or young saw-fish the snout is folded back over the head, and the rudiments of the spines are indicated by tubercles.

(119.) The third of the aberrant forms in the great family of sharks, is either represented by *Squatina*, or by *Crossorhinus*; both of which differ from all the more typical sharks, in having the mouth at the extremity of the muzzle, and not beneath it. That these two forms, as well as *Cestracion*, are perfectly analogous, there can be no question; the only difficulty is that of determining their natural situation or affinity. We confess our strong doubts on the propriety of placing *Squatina* among the sharks, rather than with the rays, to which it has certainly, of the two, the greatest resemblance both in external form and internal structure. Without, however, entering further into this question

at present, we may certainly affirm that the general shape of these animals (of which two species are known) seems a compound of both the typical forms. The hinder parts are those of a shark, while the broad depressed head is that of a ray, and it is just of such a form as we might imagine to intervene between a *Torpedo* and a *Rhinobates*. Our European species, *C. angelorum*, is generally called the angel-fish. The body, but especially the head, is flattened; and the eyes, like those of all the rays, are vertical, or placed upon the crown: behind these are spiracles; while the branchial apertures are not, as in the sharks, on the sides, but placed beneath: the pectorals are very broad, and the mouth terminal. In the American species (*fig.* 13.), the



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upper jaw has two flattened and somewhat triangular cirri: the teeth are broad at their base, but slender and sharp at their points. The *Squalus aculeatus* of authors has been also referred to this genus, to which it is evidently related; but whether by analogy or affinity appears somewhat questionable. For the present, we feel disposed to follow our predecessors in placing *Squatina* in this family; where, if it truly enters, it comes in as the chironectiform type of the whole circle. Leaving the three aberrant groups, we shall now proceed to the two which are typical.

(120.) We place the sub-family of SQUALINÆ as the next in order, because it seems connected to the *Zyganinæ* by its pointed teeth, and by the want of those remarkable temporal orifices, or spiracles, which seem

to mark the primary distinctions of the two typical groups. This character also happens to be one of the most obvious; and thus affords the ichthyologist an easy and, as we believe, a natural guide among the intricacies of the numerous genera that have been formed out of these fishes. On looking to these, we plainly perceive that, although they have hitherto all been termed genera, and therefore placed upon the same rank, yet that some are much more strongly marked in their differences than others; so that they form themselves into little groups, under which two, three, or more, may be arranged. This it would be very easy to accomplish, if our object was merely to make an artificial arrangement: but when we attempt to work out a natural group, such is the state of ichthyological science, that it almost becomes absolutely necessary to verify what has been done by our predecessors, by going over the same ground, and re-examining the major part of these sub-genera ourselves. In very many instances, however, this is totally impracticable; and in such cases we have no other resource left than to take for granted what has been published, and endeavour to trace the line of affinity by the imperfect materials before us. In the attempt, therefore, which we shall now make to place the numerous sub-genera of sharks under their genera, properly so called, the above difficulties must be borne in mind, and every allowance may fairly be claimed for those errors which necessarily attend upon a task so peculiarly perplexing. Enough, however, will come to light in the sequel, to show that this effort has not altogether been unsuccessful; and for the rest, we must leave the rectification of minor errors of location to time, — to greater knowledge of those forms already known, but imperfectly described, — and to the discovery of others which are at present unknown.

(121.) The first genus, if such it be, which we shall notice, among the *Squalinæ*, or sharks having no temporal orifices, is that of *Scoliodon* of Muller and Henle, which seems to bear a nearer affinity than any other to

Zygana. We are led to believe that *Scoliodon* is a generic, and not a sub-generic, type, from its containing five species; but as no typical example has been named, and no notice taken of the form of the head and tail (characters, in our opinion, of much greater importance than slight variations in the teeth), our idea of its rank is entirely conjectural. If Rafinesque's *Tetroras*, on the other hand, has only four spiracles, it may fill the place here assigned to *Scoliodon;* which, according to Muller and Henle*, differs only from the true sharks in the next genus, by such slight modifications in the teeth, that, in the absence of further characters, we hardly venture to incorporate it in our present survey. The genera *Triaenodon* and *Leptocharias*, each with only one example, appear to us — judging from the characters that have been as yet assigned to them † — no other than aberrant species; but this, again, is mere conjecture. It is clear, however, that they all enter into the present sub-family, as they are destitute of temporal spiracles.

(122.) The next is the typical genus of the whole family; and as such we retain to it the original generic name ‡ of *Squalus*, in preference to that of *Carcharias* proposed for it by Rafinesque, seven years before M. Cuvier. Here we meet with the most ferocious and gigantic monsters of the whole family; among these is the great white shark, *Squalus carcharias*, which sometimes grows to the length of twenty-five feet, and which is a savage and destructive wanderer over the whole ocean. Its jaws are armed with innumerable cutting teeth, acutely pointed at their tips, and generally dentated on their margins, the base being very wide and

* Mag. of N. Hist. No. xiii. p. 35. — "Differs only from *Carcharias* Cuv. by the teeth being of the same shape in the upper and lower jaw; viz. the points directed towards the corner of the mouth, with a smooth edge, and a truncated protuberance, either smooth or indented, on the exterior side of the base (5 sp.)."

† Ib. p. 36.

‡ The propriety of retaining the original name of a genus to the typical group, has been so well advocated by others, that any further observations of ours would be superfluous.

compressed. They all have an unequal tail, two dorsal fins, and one anal. In the pre-eminently typical section, or sub-genus, the tail is of ordinary length (*Squalus elephas* Le Sueur, *fig.* 14.); but in the next sub-genus,

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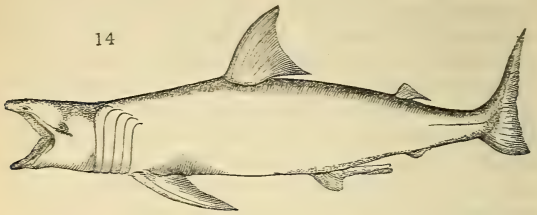

Alopias Raf., to which the *Squalus obscurus* of Le Sueur forms a passage, the upper division of the tail is excessively lengthened; a familiar example of which is seen in the fox-tailed shark of Britain (*Alopias vulpes* Nob.).* Independent of this singular development of tail, *Alopias* is further distinguished by having the snout conical, not, as in *Squalus*, broad and depressed; the teeth also are less numerous, and are only in two or three rows. The sub-genus *Cericteus* of Rafinesque is an equally distinct, but a much more extraordinary, type, hitherto found only on the prolific shores of Sicily†: it is at once distinguished by having two horn-like osseous appendages on the head, resembling horns; while its affinity to *Alopias* is manifested by its oblique, unequal, but very long tail. All the foregoing types have an anal fin, and the two dorsal fins are soft; but in *Dalatias nocturnus* of Rafinesque, which he distinctly asserts has no spiracle, the anal fin is wanting, and the two dorsal fins are spined. It has been thought by Cuvier, that the spiracles of this fish have been overlooked, and that it is, in reality, a species of *Spinax;* but we see no good reason for this belief, and a strong one against

* Figured in Yarrell, vol. ii. p. 379.
† *Cericteus macrourus*, Raff. Caratt. p. 12.

it. The habits of the fish, which Rafinesque particularly mentions, show that it is a nocturnal feeder; and it therefore becomes highly probable that it possesses a *membrana nictitans*, similar to all the groups we have hitherto noticed; whereas both *Spinax* and *Centrina*, according to Muller and Henle, have not that appendage to the eye. At all events, we must not believe an author is invariably wrong, merely because he may have committed occasional errors; for if we proceed on such a principle, who is exempt? We shall, therefore, retain the genus *Dalatias*, until it is proved false; restricting it alone to the *D. nocturnus*, and viewing it, for the present, as the representation of the spiny-finned group of *Centrinæ*, in the family of spiraculated sharks, to which, in every thing but the absence of spiracles, it seems to agree.

(123.) The genus *Selachus* Cuv. is the third of the *Squalinæ*. It has several strongly-marked characters, and appears altogether a very natural one. Unlike all the preceding, the teeth of these sharks are conic, simple, and generally small; that is, not serrated or lobed. The tail, which in all the preceding genera has been unequally lobed, now assumes the more regular appearance of ordinary fishes; its form is lunate, the two lobes being nearly equal. The third character is to be found in the extraordinary size of the branchial apertures, which are so large as nearly to extend half way round the neck. These characters are developed in the subgenera *Isurus*, *Selachus*, and *Lamna* †, the first of which appears the true type of the group. We have now arrived, however, at that extremity of the *Squalinæ*

* *Oxyrrhina* Agass. evidently belongs to this group, so remarkably distinguished by its teeth; but I look upon it as not sufficiently distinct from *Lamna* to allow of sub-generic separation. *Carcharodon*, formed on one species, is unknown to me.

† It would appear, according to Dr. Smith, that Cuvier has overlooked the spiracles of his genus *Lamna*, which Dr. Smith says are present in that group, although extremely small. There is thus as much uncertainty regarding one of M. Cuvier's genera, as in the *Dalatias nocturnus* of Rafinesque. May not Dr. Smith have mistaken some of the numerous pores, placed on the head of certain *Lamnæ*, for true spiracles? We have no means, at this moment, of settling this disputed point.

which blends into the next sub-family of *Centrinæ*, and we are consequently prepared to expect that the chief characters of the two groups also blend into each other: in this expectation we are not disappointed, for we find that the presence or absence of spiracles now becomes quite a secondary character. In the true type, which is probably *Isurus*, there are no spiracles; but in *Lamna* they first appear (perhaps not in all the species*) to be minute; and in *Selachus* we still find them very small. In all these, however, we see the three primary characters already noticed. *Isurus*, however, stands prominently forward as a most remarkable type, having the snout so lengthened and pointed as to be a representative of *Pristis:* in *Lamna*, the snout, although not lengthened, is still pointed and conic; and even in *Selachus*, the muzzle, according to Cuvier, projects far beyond the mouth. What other sub-genera enter into this group, we know not; but it is quite clear that we have now a passage opened to the spiracled sharks. Before, however, we quit this division, we may advert to another form, which seems entitled to be viewed in the light of a generic type; for, although only one species is yet known, its form is so remarkable, and so different from all others, that it must either be placed with the *Squatinæ*, or stand as the most aberrant genus in the present assemblage. We allude to *Rineodon* of Dr. Smith, having all the characters, as it would appear†, of *Selachus*, but with the mouth on the top of the snout. As this structure is totally at variance with that of the ordinary sharks, excepting *Crossorhinus* and *Cestracion*, we may fairly conclude, from the location that has been assigned to it, that it has a relation both to those and to *Squatina*. In the *Crossorhinus lobatus* M. and H. (*fig.* 15.) or Watts's shark, the mouth is also terminal, but the sides are furnished with broad cirri, or lobes. This singular fish

* This supposition is highly probable, and will at once reconcile the opposite statements of Cuvier and Dr. Smith.

† Mag. of Nat. Hist. No. xiii. p. 37. second series.

certainly does not belong to the *Squatinæ*, or even to the same genus, strictly so termed, as Dr. Smith's *Rineodon;* for the teeth are large, acute, and seem more to resemble those of our *Squalus;* both of the dorsal

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fins are placed behind the ventral; the tail is long; the caudal fin unequally and irregularly lobed: it only agrees with *Rineodon* in its terminal mouth, and the situation of the branchial openings, which appear very large, and are all placed before the pectoral fin. Whether this singular fish naturally intervenes between the *Zyganinæ* and *Pristis*, or whether it is the most aberrant type of the *Squalinæ* (in which case it would represent *Squatina* and *Rineodon*), are questions which, in the present confused state of this family, cannot be determined.

(124.) We now enter on the sub-family of CENTRINÆ, or spiracled sharks, to which we are conducted, as before observed, by the sub-genus *Selachus*, which has the general structure of *Lamna*, with the spiracles sufficiently large to become obvious, although, when compared to the sharks now before us, they still remain very small.

(125.) The first genus we shall notice in the line of affinity is *Scyllium* (*S. canicula, fig.* 16.), which,

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although agreeing with *Lamna* in its obtuse and pyra-

midical snout, and somewhat in its teeth, is at once distinguished from that sub-genus by its lengthened and unequally lobed tail, which has the same form as in the generality of sharks; like them, also, it has two sof dorsal, and one anal fin. The long snout seen in *Isurus*, appears to be, in some measure, continued in one of the sub-genera (*Pristiurus* Bon.) which authors have placed under *Scyllium*. These smaller divisions have been chiefly formed upon the different positions of the dorsal fins, and other minor characters, which, however important and interesting they may be thought, do not appear to us, taken by themselves, to lead to any clear notion on the natural sub-generic types of the group before us. As we shall notice them in our synopsis, we need not, in this place, detail their technical characters.

(126.) The genus *Galeus* has an obvious and close affinity to that of *Scyllium*. They are almost exact prototypes of the true sharks, except in wanting the temporal spiracles: all the teeth are flat and sharp; but they vary so much in their minor modifications, that Muller and Henle have divided this group into four sub-genera, viz. *Galeocerdo* and *Galeus*, where the teeth are serrated (2 species); *Loxodon*, having no serratures (1 species); and *Triachis*, with the teeth pointed, as in *Scyllium*, and without a dimple at the tail (1 species). The value of these distinctions will no doubt appear more definite, when the learned and able ichthyologists who have proposed them, publish their views more in detail: until then we feel incompetent to arrive at any conclusion on the subject.

(127.) The third genus, *Centrina*, is much more definite than the two last, and seems to be the most natural in the present sub-family. It is composed of all those spiracled sharks which have a spine placed before each of their dorsal fins, while the anal fin is entirely wanting: hence it differs from every other group in this sub-family. But this structure is not

reached abruptly: there are some which, by having no spines, evince an affinity to *Galeus;* while, from being destitute of an anal fin, they come within the confines of the present group: these form Cuvier's sub-genus *Scymnus,* which we shall, at least for the present, keep entire, since the divisions that have been made of it appear to us* too slightly marked for even sub-generic separation; more especially as there are evidently five divisions, with much more prominent characters, entering into this genus. *Scymnus* seems to represent *Selachus* in some particulars well worth noticing. To Dr. Scoresby we are indebted for all the knowledge we possess of the habits of *S. borealis,* an immense species, observed by that well-known navigator and philosopher in the Arctic seas. According to his observations, it often grows to the length of fourteen feet, and six or eight feet in circumference. Its chief food is derived from dead whales and other *Cetacea,* out of which, at a single gripe, it scoops masses of blubber as large as a man's head: hence it is, that when, on such occasions, any sailors may be in the water engaged in securing the whale, this shark is so intent upon claiming his portion, that he offers no molestation to the fishermen; indeed, he is so ravenously fond of blubber, that he has been known to return to the carcase, even after a long knife has been run into his body by the seamen engaged in cutting up the whale. The slight variation in the teeth of those species which we place in this sub-genus, seems to mark the transition from the last genus. In *Galeus,* the teeth in both jaws are serrated on the external edge, and inclined outwards; but in *Scymnus,* the upper teeth are straight and narrow, while those in the lower jaw are crooked, pyramidal, and equilateral: between these, however, are species having the upper teeth of *Scymnus,* and the lower ones of *Galeus.* From *Scymnus* we pass to one of the typical genera, both of which have the dorsal fins spined: the first is *Centrina,* which, as

* *Laemargus* M. and H., *Echinarrhinus* Blainv.

Cuvier observes, has all the characters of *Scymnus*, but with the addition of spines. The most common example of this type is the *Squalus centrina* of Linnæus, —a large, thick-shaped fish, having the spines not placed in front of the dorsal fins, but partly concealed in the skin which covers them: the anterior spine points forward, but the posterior is directed backward, and the tips of both are alone naked: the last dorsal fin is placed over the ventral; and the tail is remarkably short. We exclude from this sub-genus the *Squalus spinosus* and *squamosus* of authors, the last of which appears to us the true type of the sub-genus *Centrophorus* of Muller and Henle, the distinctive and most striking characteristic of which is the body being covered with hard carinated scales. The sub-genus *Somnolentus* of Le Sueur seems to unite this singular form with *Scymnus*, of which we consider it only as an aberrant species. The fourth sub-genus, following *Centrina*, is *Spinax* Cuv.*, where we have again the ordinary form of the sharks, but with each of the dorsal spines placed in front of the fins: the snout is rather lengthened, the tail long and unequal, and the teeth are small and cutting. The most familiar and typical example of this group is the *Spinax acanthias*, or picked dog-fish of our own seas, of which Mr. Couch has recently given us an interesting account.† It seems to be the most abundant of all the sharks found on the western coasts, where it is sometimes seen in incalculable numbers, to the no small annoyance of the fishermen, whose hooks they cut from the lines in rapid succession. One of its modes of defence is very singular, and is effected by bending itself in the form of a bow, for the purpose of wounding with its spines; and then, by a sudden motion, it causes them to spring asunder in opposite directions: so accurately is this effected, that if a finger be placed on its

* It appears to me that the sub-genus *Acanthias* Bonap. is the true type of *Spinax*, and that the single one to which Cuvier's original name is thus restricted, is but an aberrant species of *Spinax*.

† Inserted in Yarrell's British Fishes, vol. ii. p. 401.

head, it will strike it, without piercing its own skin. Its greatest size, however, seldom exceeds two feet. We cannot subscribe to the supposition of M. Cuvier, that *Etmopterus aculeatus* Raf. * is a typical example of this genus; for we know that the descriptions of this author, as before remarked, were never taken from dried specimens. The fifth of the most prominent divisions of the spine-finned sharks is the sub-genus *Cestracion* Cuv., which we have not yet seen. According to Muller and Henle, however, it has a prickle before each dorsal fin; a fact established by the figure given of the *Cest. Phillippii* by Lesson (*fig.* 17.), although not men-

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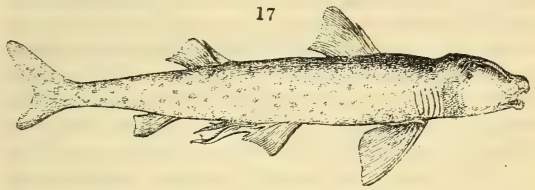

tioned, and perhaps overlooked, by Cuvier; which is somewhat singular, as he himself originally defined the genus.† In addition to this, the teeth are tesselated, —those on the anterior rows alone, being small and pointed; while the mouth, unlike all the other sub-genera of *Centrina*, is terminal, or at the extremity of the pointed muzzle. The *Cest. Phillippii* is the only species yet discovered: it is very rare, and inhabits the coast of Australasia. It is not only analogous to

* "*Etmopterus aculeatus.* All the fins and tail as if laciniated; the dorsal fins with a *detached* spine before each; the posterior one almost opposite the anal. — This is the smallest of all the sharks I have seen in Sicily, for it scarcely exceeds a foot in length, and is the only one not eaten. The fishermen distinguish it by the name of *Diavolucchio de mari*, or little sea-devil. The snout is obtuse: the nostrils are furnished with an appendage; the teeth small and acute; the tail unequal and oblique; and the branchial apertures only three."—*Raf. Caratt.* p. 14. The *Squalus uyatus* Raf., as Cuvier observes, is obviously a *Spinax*, but seems to me to differ from our northern *Spinax acanthias.*

† With such conflicting statements as to simple matters of fact, as those we have just been obliged to notice, it is almost impossible to determine the limits of any one natural genus, or even of rigorously determining any one point in the natural arrangement of this family.

Squatina, Crossorhinus, &c., by the mouth being terminal, and the eyes vertical, but still further resembles the first, in the lobes of the tail being nearly equal; so that there can be but little doubt of its being the chironectiform type of the circle of spine-finned sharks. The front view of the head, as delineated in M. Lesson's *Atlas,* gives the lateral ridges or elongated lobes an appearance of horns; but this merely results from the peculiar position in which the head is drawn.

(128.) The genus *Mustelus* is the fourth of this subfamily; and although, in its general form, it has a close resemblance to *Galeus,* it is yet distinguished from all the other spiraculated sharks by having the teeth flat and tessellated, like the rays and the genus *Pristis:* it is on his accountt that we consider *Mustelus* as the representative of a genus connected, in the most perfect manner, with that of *Centrina,* through the medium of *Cestracion,* which unites in itself the chief characters of both, joined to a peculiarity of its own.

(129.) Regarding the fifth primary group of the *Centrinæ,* much uncertainty prevails, on account of the conflicting opinions of Rafinesque and Cuvier as to the question whether *Heptranchias* has no spiracles, or whether they really do exist, as asserted by the latter. It is clear, however, that even if Lacepede, rather than Rafinesque, is in error on this point, and that *Heptranchias* is but a sub-genus of *Hexanchias,* the latter name has the priority over Cuvier's *Notidanus,*—having been published seven years before.* Leaving, therefore, the presence or absence of spiracles in *Heptranchias* to be determined hereafter, we may state that the genus *Hexanchus* is distinguished by having no second dorsal fin, and that it seems to contain two sub-genera: *Hexanchus* proper, having a depressed and rounded muzzle, and six wide branchial apertures; and *Heptranchias,*

* If there is an error in attributing no spiracles to the sub-genus *Heptranchias,* that error belongs to Lacepede, and not to Rafinesque, who founds his generic characters entirely upon Lacepede's account of his *Squale perlon* (*Hist. des Poissons,* p. 220.), without having seen the species himself, which he does not describe.

where the muzzle is pointed, as in *Lamna*, while the branchial apertures, equally large, amount to seven: the caudal fin, in both, is oblique and unequal.

(130.) We may here close our enumeration of the most prominent variations in this extensive family; and we shall now take a retrospective view of the whole. It has been our endeavour, with the imperfect and often contradictory materials before us, to trace, in some degree, the real line of continuity, and the manner in which the different forms blend into each other. Some of these affinities are much more obvious than others; but as even these latter require to be tested by the theory of analogy, we must now turn to this sort of relationship as essentially necessary to give some degree of verisimilitude to our arrangement of the *Squalidæ*, no less than that of the whole order. We shall, in the first place, arrange the orders of fishes in one column, and the families of the *Cartilagines* in another, and then see how far the contents of each are analogous in their most prominent characters.

Families of the Cartilagines.	*Analogies.*	Orders of Fishes.
Raidæ.	Back armed with spines.	Acanthopteryges.
Squalidæ.	Back with soft fins.	Malacopteryges.
Polyodonidæ.	Pre-eminently cartilaginous.	Cartilagines.
Sturionidæ.	Body mailed; mouth very small.	Plectognathes.
Chimæridæ.	Tail excessively lengthened.	Apodal.

(131.) Before the naturalist enters upon the investigation of these comparisons, we beg to remind him of one important consideration, that must always be borne in mind in all investigations of this nature, namely, that we are to look only to the pre-eminently typical characters of each group, and not to the exceptions which always, and inevitably, occur in those which are aberrant. It is no more meant, for instance, that *all* the rays are armed with stings, than that *all* the *Acanthopteryges* have spined dorsals: here the absence of spines is the exception to the general character, just as their presence is the exception among the *Squalidæ* and the *Malacopteryges*.

We have illustrated this position so fully in the two most perfect classes of vertebrated animals, and more especially among birds, that it appears hardly necessary to touch upon the subject in this place; but as this volume will, doubtless, be perused by many ichthyologists who have not turned their attention to ornithology, it seems necessary to explain to them the leading principle upon which we universally proceed in analogical comparisons, and upon which the essence of our theory depends. True it is, that there are sharks with spined dorsal fins; and this fact would appear to invalidate the character we have given to the family; but it will be seen that these spined sharks are not the most typical, and therefore they are not taken into the account at present: the same may be said of such as, from being covered with spines, are analogous to the sturgeons and the cheloniform fishes. In explanation of all which we may observe, that these minor variations, belonging only to aberrant forms, are to be explained by this simple law of nature,—that every circular group, whether large or small, contains within itself representations of all other groups; so that if, among the sharks, there were none with spined rays, there would be no representation of the order *Acanthopteryges*, and (unless other analogies to that order existed) the sharks would be an imperfect circle. We hope the experienced zoologist, to whom all this is well known, will excuse our again explaining these views to the general student, and we shall now proceed to the comparison above intimated.

(132.) The most typical forms of the rays, as will subsequently appear, are those whose backs are provided with a formidable spine, usually, although improperly, denominated a sting. This weapon is placed, indeed, upon the tail, generally near its base; but so also is the first dorsal fin in several types of the sharks; so that it becomes no more nor less than are presentation of the first or spinous dorsal fin of acanthopterygious fishes. It may be here observed, that some of the rays have two spines, analogous to the two dorsal fins of

the *Acanthopteryges*. That the rays also are the most typical of the whole order, may be inferred from two circumstances. Of all the *Cartilagines*, they have the broadest snouts, just as the fissirostral or natatorial types, among birds, have the broadest bills; while the peculiar form of their body, which may be said to be surrounded with two immense fins, must give them a greater celerity of swimming than is enjoyed by all their congeners. Such is exactly the case with the fissirostral and natatorial birds, of which the swallow, the goat-sucker, the albatross, and the *Tachypetes* are familiar examples — well known to every ornithologist — where, as in the rays, the organs of flight considerably exceed the size of the body. There can be no doubt, therefore, that these analogies are founded in that law of representation, which assimilates all these groups to one of the primary types of the animal creation. If the rays, therefore, represent the *Acanthopteryges*, the *Squalidæ*, by which they are immediately followed, must bear a corresponding relation to the sub-typical order of fishes; the chief character of both consisting in their having the fins soft. The genus *Centrinus*, indeed, is furnished with spines: but it is clear, even upon the bare opinion of Cuvier, that this genus is not typical of the sharks; that station being assigned by him to the *Squalus carcharias*, and its allies, to which we have retained the original patronymic name of *Squalus*. The *Squalidæ*, therefore, by following the rays, become the sub-typical family of the cartilaginous order; and this analogy at once explains the relation they bear to the *Feræ* among quadrupeds, and the *Raptores* among birds. Like these, their representatives, they are proverbially the tigers and panthers of the ocean; and frequently carry upon them, as it were, the very spots and markings of those ferocious beasts, as if Nature was determined to make her analogies plain, whether they were studied or not. These relations of the two chief groups being thus established, we must be satisfied if those that are aberrant are less determinate; because, as the forms

contained in the order before us are very few, our materials for comparison are as 1 to 10 less numerous; and yet, upon study and reflection, we shall find that the same train of analogies can be traced, although, perhaps, they may appear to some less perfect than in the instances already explained. But to proceed: —

(133.) It will be seen that the genus *Polyodon*, which represents a family, stands opposite to the *Chondropteryges*, or cartilaginous order. We place this genus close to the sharks; M. Cuvier does the same; and, therefore, the scruples of those who form their opinions on previous authority will not be disturbed. But it may be immediately asked, how can *Polyodon*, which departs in so many points from the cartilaginous structure, be, at the same time, a typical representation of that order? To answer this, we shall cite an accidental remark of M. Cuvier's, which, in our opinion, at least, is quite conclusive. In speaking of the *Polyodon*, he remarks, that the spinal column merely consists of one entire piece, like the lamprey. Now, as one of the greatest characteristics of the order before us is to have the spinal column cartilaginous, and less developed than in any other order, so it results, that the most imperfect fish, in this respect, among the whole of the known *Chondropteryges*, is the *Polyodon*, which thus represents them in its own circle. Did this peculiar construction constitute the *only* character of the order, then, indeed, *Polyodon* would stand at the head, and occupy that station we have given to the rays: but this is not the case, either in nature or in any system. *Polyodon* has an enormous gill-cover, with a large branchial aperture, nearly similar to the generality of fishes; it is, besides, furnished with an air-bladder; and thus nearly all other parts of its structure are directly opposed to the idea of placing it at the head of the cartilaginous fishes, merely on the strength of having one of their characters uncommonly developed: thus, also, we see that every fact regarding the anatomy of an animal, however bare and barren it may appear, at first, of ulterior interest,

may yet become of the greatest importance in our endeavours to determine the different relations which subsist between animals, whether by affinity or analogy.

(134.) Our next comparison is between the sturgeons and the cheloniform fishes, or, in other words, the *Sturionidæ* and the *Plectognathes* of Cuvier. This analogy will not detain us; for the very aspect of the two is quite sufficient to show us we are following in the right track. The types of both are incased, as it were, in armour; the head and body being defended by large bony plates, which either compactly join at their sutures, as in *Tetraodon*, or assume the form and substance of little targets or shields having a sharp central spine; the mouth, in both groups, is very small; and the absence of true teeth in both is supplied by an acute elongation of the jaws. This latter character, which is one of the primary distinctions of the cheloniform fishes, is found still more developed in the next type of the cartilaginous order; and this at once brings us to the only remaining analogy, namely, that between *Chimæra* and the apodal or anguilliform fishes. Now, it may be observed, that throughout the whole of the cartilaginous groups which we have yet noticed, there is not one which gives us any idea of that slender and attenuated form which belongs to the eels among fish, and to the serpents among reptiles; and yet in the *Chimæra* we actually see a fish having the fore part of a shark, and the tail, or hinder part, of an eel. Thus does Nature combine her primary forms: and yet, that analogy should preserve a due subordination to affinity, the primary characters, as well as the whole aspect, of these singular shaped fishes, are decidedly those of the true *Cartilagines*, yet so modified as to point out its relations to other groups. Of all the cartilaginous fishes yet discovered, the *Chimæræ* are those only that have the second dorsal fin very narrow, excessively long, and gradually tapering to the point of the tail; being all but united to the caudal fin. This latter character, as is well known, pervades the whole of the anguilliform

fishes ; and both agree in having only one small external branchial opening. The other peculiarities of *Chimæra* relate to its three affinities — on one side to *Acipenser*, on another to the *Raidæ*, and on a third to the *Plectognathes*, — all of which will be noticed in their proper place.

(135.) Such are the analogies, resulting from our following closely the line of affinity, and upon which we rest our belief that the five types of the cartilaginous order represent the five great divisions of the class *Pisces :* but on a question of such paramount importance to the philosophic naturalist, it appears necessary to take a still wider range ; and, by looking to the whole circle of vertebrated animals, endeavour to test the correctness of this series by bringing it into comparison with the great groups of the *Vertebrata*. The resemblances, of course, will be far more remote, because the dissimilarities are immeasurably greater ; but yet, if our arrangement is true to nature, these resemblances, however faint some may think them, must not only exist in part, but must follow each other in an harmonious and definite order. Placing, therefore, the contents of both groups in separate columns, we shall find some of the analogies both curious and interesting.

Analogies of the VERTEBRATA *and the Cartilaginous Fishes.*

Circle of the CHONDROPTERYGES.	*Analogies.*	Circle of the VERTEBRATA.
Squalidæ.	Partaking most of all to the structure of the *Cetacea*. Viviparous.	QUADRUPEDS.
Raidæ.	Pectoral fins assuming the form of wings. All oviparous.	BIRDS.
Chimæridæ.	Posterior part of the body, or the tail, gradually attenuated and pointed.	REPTILES.
Sturionidæ.	Most aberrant in their respective circles. Teeth none.	AMPHIBIA.
Polyodonidæ.	Gill opening very large ; gills pectinated.	PISCES.

(136.) The following points of analogy do not admit of much illustration, seeing that they are remote ; and

yet it is most extraordinary to observe the perfect regularity with which they follow each other. Every zoologist will confess the likeness between the sharks and the porpoises, even in their external appearance: and while no fish make such a near approach to quadrupeds as the sharks, no quadrupeds more resemble true fish than the *Cetacea:* this, of itself, is a fact so far beyond dispute, that we may at once pass on to the next analogy. The enormous pectoral fins of the rays, and the remarkably small size of the others, which are nearly obsolete, incontestibly prove that in them is concentrated nearly all the powers of locomotion, and accounts at once for the excessive rapidity with which they swim: this is precisely the case with birds; whose wings correspond anatomically with the pectoral fins of fishes. The very appearance of some of the rays shows that nature intended to make them represent the feathered class; and this analogy is so apparent to ordinary observers, that several have acquired the name of sea eagles, eagle rays, &c. As the eels obviously represent the serpents, so do the *Chimæridæ* represent the reptiles, the primary external character of which consists in the tail being excessively lengthened, and gradually ending in a point. The *Chimæridæ* are the only cartilaginous fishes yet discovered, that have a tail thus formed; and they cannot, therefore, be likened to any of the vertebrated divisions, excepting the reptiles. The analogy between the sturgeons and the *Amphibia* is not only faint, but even obscure. But this may be easily accounted for in two ways: first, it is an indisputable fact that the analogies between two groups of animals thus compared, are almost always weakest between their most aberrant types; and secondly, because, when there are so few species in a group, as in the *Sturionidæ*, we have not the same facilities or materials for determining its analogies, as when it is more numerous: the points of comparison, in short, are few; and setting aside the ignorance under which we may labour, we must, in all such cases, rest satisfied, if what is really known does

not militate against our other analogies. So far, however, is this from being true in the present instance, that we actually find the *Sturionidæ* coming opposite to the *Amphibia*, when we bring the circles of the *Vertebrata* and the *Cartilagines* together: there are even some considerations which strengthen the analogy thus inferred. The sturgeons, like the *Amphibia*, have no true teeth, and they live in two distinct modifications of the same element,— that is, both in salt and fresh water. The simple fact, however, of their standing in the order of affinity (for *this* is the primary consideration) between the *Chimæridæ* and the *Polyodonidæ*, and that the *Amphibia* hold the same rank between the reptiles and the fishes, is a sufficient argument that they represent each other, although we are not prepared to state the true manner in which this law of nature is effected. We now come to the *Polyodonidæ* and the class *Pisces*. We are to inquire under what view we may consider the former as a representation of the latter: it is not sufficient to say that *Polyodon* is a fish, because so are all the *Cartilagines*. Now, if the question was asked, What are the most prominent characteristics of the typical orders, independent of their general form? the answer would be, that such fish possessed free laminated gills, with a large and unconfined branchial opening. These, then, are the very characteristics of *Polyodon;* and as they are found in no other type of the cartilaginous circle, it follows that this division, more than any other we have noticed, gives us the best representation of the ordinary and typical structure of the class *Pisces*.

(137.) We have had frequent occasion to remark, while tracing the analogies among quadrupeds and birds, that, to illustrate all the peculiarities of an animal, one table of comparisons is not sufficient: many others would then remain; and we can only explain these by instituting other comparisons, and applying further tests to the accuracy of our theories. Now, the aberrant groups of the order before us particularly require his,

especially *Polyodon* and *Chimæra*, of which nothing that we have yet said relates to the enormous flattened snout of the first, or the lobe-shaped crest of the last. We shall, therefore, now exhibit the analogies of the cartilaginous types in a new light, by bringing them into contact with the primary orders of birds.

Families of the CHONDROPTERYGES.	*Analogies.*	Orders of BIRDS.
Squalidæ.	Pre-eminently rapacious.	RAPTORES.
Raidæ.	Typical of their respective circles.	INCESSORES.
Chimæridæ.	Males with crests or frontal appendages.	RASORES.
Sturionidæ.	Mouth very small.	GRALLATORES.
Polyodonidæ.	Snout or bill excessively broad.	NATATORES.

(138.) The two first set of analogies are so obvious, that every naturalist will at once perceive them. It follows, indeed, as a necessary consequence, that if the sharks represent the beasts of prey, they also represent the rapacious order of birds; and that if the *Raidæ* are typical of birds, they must bear the same relation to that group which is the most perfect among birds. The rasorial type of form, already so much enlarged upon in former volumes, is eminently distinguished from all others by the heads of one or both sexes being ornamented or defended by unusual appendages, which among quadrupeds take the shape of horns, and in birds that of crests. The *Chimæra borealis* exhibits an appendage perfectly analogous to this, in the singular fleshy caruncle or lobe which surmounts its snout, the end of which is beset with numerous short prickles; while the tail, as in all rasorial types of the *Vertebrata*, is highly and singularly developed. Thus we have, among fishes, a structure perfectly analogous to the rasorial order of birds, and to the ruminating order of quadrupeds; and as the types of the rasorial birds (the family of peacocks) are among the most splendid coloured of the class, so *Chimæra* is the only group among the cartilaginous fishes whose colours have any degree of brilliancy. The difficulties attending the

analogies of the *Sturionidæ* have been already stated, but we may remark, that the smallness of their mouths is in complete accordance with that structure which is one of the most marked peculiarities of the *Grallatores*, or wading birds; while the order *Edentates*, among quadrupeds, — the types of which have their bodies covered with bony scales like the sturgeons, — is an indirect proof in support of the opinion that all are representatives of each other. Lastly, the *Polyodonidæ*, and the natatorial type of birds, are those only which have the snout or bill excessively broad and uncommonly flattened. That *Polyodon*, therefore, is the natatorial and, consequently, the fissirostral type of the cartilaginous circle, cannot be doubted, because its snout is much longer and broader than in any other fish yet discovered; and we thus get an explanation why, in a group which is collectively a natatorial type, it should yet have one of the peculiarities of that type so pre-eminently conspicuous.

(139.) To trace the analogies of the cartilaginous families further, might weary the reader, and may be thought unnecessary by the naturalist; seeing that all the peculiarities of the two most singular forms in the group, *Polyodon* and *Chimæra*, turn out to be in perfect accordance with those ordinary laws of variation which nature adheres to in other divisions of the vertebrated animals, and which we hope to trace hereafter in the annulose circle. There can be no doubt that innumerable analogies, equally strong, exist between them and their representatives among the osseous fishes, which may hereafter add additional force to what has just been elucidated.

(140.) The analogical relations of the primary divisions of the order being now disposed of, we shall again revert to the family of *Squalidæ*, for the purpose of ascertaining whether the same system of representation can be traced in its sub-families. In endeavouring to determine these latter, it will be remembered that we have noticed them in the following order: *Zyganinæ*,

Squalinæ, Centrinæ, Pristis, and *Squatina* or *Crossorhinus;* the first and the two last forming the aberrant group, while the second and third are considered as the typical and the sub-typical. Let us place these in one column, and the primary divisions of the *Cartilagines* in another, and then trace their analogies.

Analogies of the SQUALIDÆ *to the* CARTILAGINES.

Sub-families of the SQUALIDÆ.	*Analogical Characters.*	Families of the CARTILAGINES.
Squalinæ.	Dorsal fins generally without spines.	SQUALIDÆ.
Centrinæ.	One acute spine on the first or second dorsal fins.	RAIDÆ.
Pristinæ.	Snout produced, armed with prickles or spines.	CHIMÆRIDÆ.
Crossorhinæ.	Mouth furnished with cirri.	STURIONIDÆ.
Zyganinæ.	Head or snout excessively broad.	POLYODONIDÆ.

(141.) There is a somewhat intricate point, which the last table brings more immediately before us, upon which we must here say a few words. In the present infant state of philosophic ichthyology, it is not likely to claim that attention it will hereafter most assuredly receive; but we shall now advert to it, to show it has not escaped our observation. This point regards the rank of pre-eminence among the *Squalidæ.* It may be argued, that if the *Raidæ* are typical of the order *Cartilagines,* then it would seem to follow that the *Centrinæ,* which clearly represent them, are also typical of the *Squalidæ:* both are distinguished by their spined backs, which make them also analogous to the *Acanthopteryges,* the most typical of all the fishes. By regarding the *Centrinæ,* therefore, in this light, we give to all the groups we have just named one and the same rank; that is, of being the pre-eminent types of their own circles: nor does there appear any great objection to this, if we only look to the groups just noticed. But how would the case then stand, regarding the analogy between the rays and birds? for the latter are most certainly not the pre-eminent types of the *Vertebrata,* and therefore the rank of these two would still remain dif-

ferent; that is, the rays would be a typical, and the birds a sub-typical, group. This latter denomination, as applied to the class *Aves*, is so unquestionable, that it must remain undisturbed. *Analogy* must always be made subservient to *affinity*; and as this very transportation of the two typical groups has been frequently observed in ornithology, we must leave it to time, and a better acquaintance with the theory of variation, to clear up a question so beset with difficulties.

(142.) The analogies of the two first groups in each of these columns are, of course, only applicable to the typical examples of each; while the only exception to the whole of the *Squalinæ* being destitute of spines, rests on the question whether the *Dalatias nocturnus* of Rafinesque has been correctly described as without spiracles: should this really be an error, then this supposed genus must be abolished, and the above-named fish will become, as Cuvier conjectures, a species belonging to the *Centrinæ*. This question, however, is of no importance to our *present* purpose, for we are looking to large assemblages, not to the peculiarities of the subgenera: besides, it is quite clear that, even if some of the sharks without spiracles have spinous fins, the greater portion have not; while, as the majority of those with spiracles also possess spines, this latter character becomes one of their typical distinctions. In this manner, the *Centrinæ* will, of course, represent the rays. Now, the nearest approach which is made by the sharks to the saw-fish, seems to be by the genus *Mustelus*, because it has, like *Pristis* and the rays, tesselated teeth; hence we have supposed that they are united by affinity, although there appears an *hiatus* between *Mustelus* and *Pristis*, which nothing yet known is calculated to fill up. Whether we are correct in this supposition, time only will show. The analogy of *Pristis* to the *Chimærinæ* is manifested by the tooth-like processes of their snouts; those in *Pristis* assuming the form of teeth, those of *Chimæra* prickles. It might be thought, indeed, that *Pristis* was more analogous to *Polyodon*, because the

only remarkable difference between their snouts consists in the one having bony or tooth-like processes, while that of the other is smooth: but this difference is a very important one, because no fissirostral or aquatic types, whether among birds or quadrupeds, have the snout horned.* The spined processes, therefore, of *Pristis*, placed on the snout, are completely analogous to the horns of ruminating quadrupeds, and to the prickles on the prolonged frontal lobe of *Chimæra;* and both represent, however imperfectly or obscurely — for how could it be otherwise? — the rasorial birds, and the ungulated quadrupeds. Between *Crossorhinus*, *Squatina*, and the *Sturionidæ*, the analogy is very slight; since the only resemblance to be traced between them, at present, is their mutual possession of cirri, or fleshy barbs, round their mouths. We should almost have hesitated — indeed still hesitate — in definitely placing *Squatina* among the sharks; because it seems to have, in its general aspect, as already observed, a much nearer affinity to the rays. Lastly, we come to the resemblance between the *Zyganidæ* and the *Polyodonidæ*, which agree in this one fact,—that both have the broadest heads or snouts of all the groups we have been comparing. The forms of the two fishes are certainly dissimilar; because the snout of *Polyodon* is, although very wide, more remarkable for its length; while that of the hammer-headed sharks is very short and obtuse, yet excessively wide. It is clear, however, that, as both are fissirostral types, they represent each other; although we by no means feel confident that the precise situation we have assigned to the *Zyganidæ* is the correct one.

(143.) The peculiar difficulties, already adverted to, in our attempt to arrange the sub-families of *Squalinæ* and *Centrinæ* in their natural series, and to designate their primary divisions or genera, bring with it corresponding difficulty and uncertainty in attempting to trac-

* The *Ceratodon* (*Monodon monoceros*), although in the aquatic order of *Mammalia*, is but a representation of the rasorial or ruminating type among the *Delphinidæ*, or porpoises.

their internal analogies. Some of the more recently characterised forms we have not personally examined, and others are not now before us, so that we had almost determined not to have prosecuted our analogical views further than to the sub-families: but this might have given an impression to some few of our naturalists, that the theory *could* not be carried further, and that we deserted our former declaration, that *every* group, whether large or small, if natural, would contain representations of all others. To show, therefore, that, even in our present dilemma, there is some ground for this assertion — so fully demonstrated already in the class of birds — we shall make the attempt. If one or two of these analogies carry with them an appearance of truth, our principle, substantially, is gained; while, for the rest, if we are in error, these very errors will serve as land-marks to others, and elicit that additional information which is absolutely essential before we can hope to work out the internal affinities and analogies of the great number of forms comprised in the sub-families *Squalinæ* and *Centrinæ*.

Analogies of the SQUALINÆ *and the* CENTRINÆ.

Genera of the SQUALINÆ; no spiracles.	*Distinctive and analogical Characters.*	Genera of the CENTRINÆ; with spiracles.
Squalus Linn.	Typical of their respective groups.	*Centrina* Cuv.
Dalatias Raf.	Spines to the dorsal; no ventral fin.	*Galeus* Raf.
Isurus Raf.	Snout or muzzle excessively long, projecting beyond the mouth.	*Scyllium* Cuv.
Rineodon Smith	Mouth at the end of the muzzle: eyes vertical.	*Cestracion* Cuv.
Scoliodon M. H.	The second dorsal fin opposite the anal: the two last branchial openings placed above the pectoral fin: teeth the same in both jaws.	*Mustelus* Cuv.

(144.) It will tend much to elucidate the above table, if we first of all briefly recapitulate the reasons that have induced us to arrange these two series in the order in which they now stand; so that, before entering on an explanation of the analogies they bear to each other, we shall take a hasty glance at the affinities of the genera

respectively placed in each column. We must first, however, remind the naturalist, that the groups in these columns are what we consider to be *genera;* and that, consequently, those numerous sub-genera which have been proposed by other naturalists, and whose names do not appear in the above list, are considered by us of subordinate rank, and form a part of one or other of these genera. One instance will better explain our meaning: M. Cuvier's sub-genus *Selache* is not mentioned, because we consider Rafinesque's *Isurus* is the true typical example of the genus which connects the *Squalinæ* and the *Centrinæ*. This union of two circles is always effected either by the rasorial or the fissirostral type; and the long snout and forked tail of *Isurus* clearly show that it is of this latter description: *Selache,* indeed, is an excellent sub-genus, but it is subordinate to *Isurus;* and therefore, as every group should bear the name of its most typical example, we name it, in the present instance, accordingly. In like manner, *Pristiurus* of Bonaparte, from what little has been said of its form*, appears the true type of *Scyllium,* because it is said to have a "long snout,"—the exact character of *Isurus* in the opposite circle of the *Squalinæ;* so that we may fairly suppose they are analogous. As our acquaintance, however, with *Pristiurus* is so slight, we shall for the present retain the long-employed name of *Scyllium.* But it may fairly be asked, Upon what principle do we ground our belief that one group is a genus, and that another is a sub-genus? and why, in reference to the above case, has not *Selache* as great a claim to be considered the type of a genus as *Isurus?* To this we reply, by stating the especial object of the present inquiry: our purpose is to show that each of the two typical sub-families of the sharks — the *Squalinæ* and the *Centrinæ* — represent each other in their respective circles; and that the subordinate divisions, or genera,

* Muller and Henle, Mag. of Nat. History, 2d series, vol. ii. p. 34.

of one, correspond to those of the other, — but with this difference, that all of one are furnished with temporal spiracles, which spiracles are not seen in the other. Having, therefore, endeavoured, in the first instance, to make out the affinities of each among themselves, we then select, from all the minor groups that have been named, those which correspond, in some way, to each other: these we denominate genera, and place all the others as sub-genera: the distinction, therefore, is neither empyrical nor arbitrary; however we may err in the selection, the principle upon which that selection has been made is sound and philosophic. We have little doubt that nearly all the divisions of Rafinesque, Cuvier, Muller, Henle, Smith, Le Sueur, &c. will arrange themselves in the line of affinity, either as genera, sub-genera, or aberrant species: but we repeat our belief, that our existing information on this family is not sufficient to carry us through such an analysis. By far the greater part of the specimens of sharks, seen in museums, are miserably preserved, — the natural form completely destroyed by having the skin either dilated or contracted; while the mouth is either closed, so that the teeth are not seen, or the jaws are taken out, or the specimens are of young individuals before the teeth are well developed. We look forward, indeed, with much interest to the forthcoming publication of MM. Muller and Henle upon this family, satisfied that in many respects it will add much to our general knowledge of this group. But we consider the principles of their arrangement, so far as it has been developed, as essentially artificial, being framed without any regard to the other groups of ichthyology; and we look on all systems founded, as this is, upon the teeth, as liable to much fallacy, because these organs are well known to vary in young and adult specimens, as well as in mature old ones, of species which follow close upon each other in all the remaining points of their organisation. Our chief desiderata, in fact, are accurate drawings, and *full* descriptions, made from the fresh subject, and from adult

specimens. This, of course, can only be done by slow degrees, and by different naturalists in various parts of the world: but the spirit which is now abroad, particularly among the rising naturalists of our colonies, will do much to hasten this; and the time will then come, when the groups of the *Squalidæ* will be established on the best of all foundations, — their analogical resemblances. This digression, although long, may not be thought out of place; and we shall now proceed, as we intended, to recapitulate the affinities of these two groups, before we enter further upon their analogies.

(145.) Let us first take the genera of the *Squalinæ*, or those sharks which have no temporal spiracles. Commencing with *Squalus* (improperly named *Carcharias* by Cuvier*), we find a numerous assemblage composed of *Alopias* Raf., *Cericteus* Raf., and many others, imperceptibly leading to *Dalatias*. Of this latter, Rafinesque expressly says, that although his *D. nocturnus* has spines on the dorsal, yet that it has no spiracles and no anal fin. It is worthy of remark, also, that he places this genus close to our *Squalus*; observing, that it differs from that in having no anal fin, and from *Centrina* Cuv. (*Squalus* Raf.), in having "no spiracles." From this we pass to *Isurus*, Raf., distinguished — as are all fissirostral types, both of birds and beasts — by a very lengthened snout, and a deeply forked, equal tail. Another character, more general in this genus, is the excessive size of the branchial openings; and both these latter characters are found in *Selache* and *Lamna*. But now, having reached the passage to the *Centrinæ*, we begin to see the incipient development of the temporal orifices, asserted by Dr. Smith to exist in *Lamna*, where Cuvier says they are not to be found. Next follows *Rineodon* Sm. which

* We say improperly, because, in this instance, and in numerous others, M. Cuvier, while he professes to retain the genus *Squalus*, virtually abolishes it; since he does not preserve the original name to any one of its divisions.

Muller and Henle consider is so closely allied to *Selache*, that they actually place them close together. Finally, we quote the same authority for placing *Scoliodon* next to our *Squalus;* for, according to these eminent naturalists, the one follows the other, and so nearly coincide in their teeth, that those of *Scoliodon* "differ only in being of the same shape in both jaws;" — and thus we return to the point from whence we commenced.

(146.) We now turn to the other column, composed of the *Centrinæ*, having temporal spiracles. At the head of these stands Cuvier's genus *Centrina;* under which we place, as sub-genera, *Spinax* and *Scymnus*. This latter, being aberrant, has no spines to the dorsal, but, in the words of M. Cuvier, it has, in every other respect, "all the characters of *Centrina*." *Scymnus* brings us immediately to the genus *Galeus* (Raf. Cuv.), under which we may place *Notidanus* Cuv., and perhaps *Etmopterus* of Rafinesque, as uniting *Scymnus, Galeus*, and *Centrina*. *Somniosus* Le Sueur, from not having an anal fin, seems to belong to the same group. And, indeed, it almost seems that the next genus after *Centrina* should consist of those sub-genera which have neither dorsal spines nor anal fins; in which case *Galeus* will stand only as a sub-genus connecting *Mustellus* to *Centrina*. We now arrive at that division which leads to the *Squalinæ;* and we consequently find that some of the sub-genera associated with *Pristiurus* Bon., as *Scyllium* Cuv., and *Chiloscyllium* M. and H., begin to have the temporal orifices very small, so as to blend with *Lamna*, and other subordinate forms in the circle we have just left. In all these, as MM. Muller and Henle have well observed, the first dorsal fin is never placed before the abdominal fins. *Cestracion*, another genus with spined dorsals, seems to follow the last; and thus we arrive at *Mustelus*, the affinity of which with *Centrina* is manifested in all but the teeth, which resemble those of the saw-fish and skates.

(147.) The result of this disposition of the groups is seen in the preceding table, which shows the analogies existing between their component parts. From these it would appear that each has a division (*Dalatias* in one, and *Galeus* in the other), where the ventral fin is wanting, and the dorsal fins are spined. Again, *Isurus* and *Pristiurus* (which latter we have arranged with *Scyllium*) are the longest-snouted sharks yet discovered: while *Rineodon* and *Cestracion* represent each other by the very reverse of this latter character; for the mouth of both is described as being at the extremity of the muzzle; and thus they also represent *Squatina* and *Crossorhinus*. With these striking coincidences before us, we need feel less regret at not being better informed on the new genus *Scoliodon* of MM. Muller and Henle; but the short characters they have assigned to it singularly coincide, in all but the teeth, with those of *Mustelus:* and as this latter genus opens a passage to *Pristis*, so we may expect that it would possess some one of its characters; and this expectation is realised by the structure of the teeth, which are precisely alike; *Mustelus* including the only sharks where these organs are blunt and tesselated, as in the rays and saw-fish.

(148.) That errors may eventually be discovered in this imperfect sketch of the natural arrangement of the sharks, is only what we fully expect; and this, for the reasons already stated, we should say would be inevitable. But whether these errors are few or many, the main facts which we have sought to establish, of there being certain types, representing each other, but without mutual affinity, will remain unshaken; and further, that those types correspond to others pervading every group in ichthyology. We contend not, in this case, for details, or for the accuracy of minor combinations: all we seek to establish at present, is the theory of representation; and for this there seems to be conclusive evidence. The two typical groups may possibly possess other characters than the mere absence or

presence of spiracles: one may be viviparous, the other oviparous—(and this deserves much investigation); but still there will be corresponding relations, however these relations may be exhibited; and that arrangement which places them in the clearest light, must always be that which is nearest to *Nature*.

(149.) The RAIDÆ, or rays, succeed the sharks, to which, as before remarked, they are closely and intimately united by the saw-fish (*Pristis*): they are composed of the rays, properly so called, having the base of their tail armed with a sting, and of the torpedos, skates, and thornbacks. The two latter, from being well known and very abundant in our own seas, will give the general reader a correct idea of the whole family. Taken collectively, they may be called the flat fish of the cartilaginous order, and, in this respect, show a marked and unquestionable analogy to that family of osseous fishes. The whole of the species, like the sharks, are marine; and several of those found in the warmer latitudes grow to a very great size. The depression of their body is fully as great as what we see in the *Pleuronectidæ*, or true flat fish; but the head and eyes are symmetrical; while the pectoral fins are of such vast magnitude, that they actually extent all round the head and body, and terminate only at the base of the small ventral fins, thus giving the body a disk-like form: the tail is excessively slender; and the dorsal fins, when present, are generally remarkably small, and placed upon their slender tail. In the typical species, the caudal fin is mostly wanting, as the tail ends in a slender point; but in others, as the torpedo skates (*Raiæ*) and shark rays (*Rhinobates*), there is a small caudal, whose size seems regulated by the comparative diminution of the pectorals. The scapulæ of the pectorals are articulated with the spinal column, just behind the branchial spiracles: the eyes, and the large temporal orifice immediately behind them, are, of course, placed on the upper surface, at a considerable distance from the snout and

the circumference ; but the mouth, nostrils, and branchial apertures are on the under surface, and are completely hid when the fish is laid on its belly : the latter organs are generally five in number, arranged on the sides, and are of the same form as in the sharks. The rays of the fins, like the rest of the skeleton, are cartilaginous, straight, and furnished with numerous swellings or knots. The mouth is small, and furnished with numerous small blunt teeth, which are placed in rows, like paving stones or mosaic, so as to completely cover the lips or edges of the mouth : the eyes are protected by a nictitating membrane or skin, which can at pleasure be drawn over them like an eyelid, —a character which is common to many of the sharks : at some distance above the eyes are situated the nostrils, each appearing like a large and somewhat semilunar opening, edged with a reticulated skin, and furnished internally with a great many laminated processes, divided by a middle partition, and guarded by an exterior valve : behind the eyes are the temporal orifices or spiracles, communicating with the mouth and gills ; these orifices are much larger than those of the sharks, and often exceed the size of the eye ; and all these parts taken together occupy a wide extent of surface. The young are contained in oblong square capsules, of a horny substance, with a filament, more or less lengthened, at each of the four corners. It would seem that the female has the faculty of twisting these round the stems of marine plants or corals, so as to secure the capsule from being tossed about and drifted by the waves. These cases, when the young have been exuded, are finally detached, and are often cast upon the shore in considerable numbers, when they are called sea purses by the common people.

(150.) Little is known of the natural history of these singular fishes : inhabiting the depths of the ocean, they elude the inquisitive eye of man ; and we can only form a few conjectures by their general structure. We know that the *Pleuronectidæ*, or true flat fish, lie concealed at

the bottom of the sea, among weeds and mud, and thus watch for their prey: hence it may be safely inferred that habits, somewhat similar, belong to the rays. The unusual development, however, of their pectoral fins, places it beyond doubt, that they can pursue their prey with a swiftness surpassing that of all other fishes; an inference which is further strengthened, when we remember that these swallow-like fish stand at the head of the fissirostral type of the class *Pisces*, corresponding to the swallows among birds, and the *Natantia* among *Mammalia*. Some of the species grow to an immense size, — a circumstance that may be accounted for by the supposition that cartilaginous fish continue to grow as long as they live. A species of skate, common to the British seas (*Raia batis*) is frequently caught of immense dimensions, sometimes weighing two hundred pounds. But this is nothing to another individual of this family, which is stated to have been caught in the West Indian seas, whose length was twenty-five feet, while its greatest breadth is stated at thirteen; the tail alone measuring fifteen feet. The sting rays, of which this last was probably a species, are, perhaps, the largest in their dimensions of the whole family. Two specimens of the *Pterocephalus massena* Sw. of the Mediterranean, were caught near Nice, and seen by Risso, which measured twelve feet long, and twenty-seven in circumference; the weight of the female was 1250 pounds, but that of the male only 800. The *Pteroceph. Banksianus* is a still more gigantic monster; for although its weight was not ascertained, it is said to have required no less than seven yoke of oxen to drag it on shore. There is some evidence, also, that these monsters of the deep, like the sharks, are destructive to mankind. Colonel Hamilton Smith relates, that he once witnessed the destruction of a soldier off Trinidad, by one of these immense *Pterocephali*. It would seem that the soldier wished to desert, and, being a good swimmer, he had jumped into the sea from the vessel, which then lay at

anchor in the entrance of the Bocco del Toro. The circumstance occurred soon after daylight, and the man, being alarmed by the call of a sailor up aloft, endeavoured to return to the ship; but the monster threw one of his fins over him, and he was never seen more.

(151.) The natural arrangement of the family has never been yet attempted. MM. Muller and Henle have just made considerable improvements on the method and nomenclature of Cuvier, by separating and defining many of the subordinate types, passed over in the *Règne Animal;* but their arrangement has no ulterior object, and merely aims at characterising the divisions. Having paid some little attention, therefore, to this family, we shall endeavour, on the present occasion, to determine the natural series of its variation, and shall subsequently show that this is regulated by the same general law that pervades all the other groups of ichthyology. We arrange the whole family under the five following divisions: — 1. The RAINÆ, or true rays; 2. The MYLIOBATINÆ, or eagle rays; 3. The TORPEDINÆ, or torpedo rays; 4. The SQUATINÆ, or shark rays; and, 5. The RHINOBATINÆ, or snout rays. The two first of these are typical, and are distinguished by their very slender and whip-like tails; while in the three latter, or aberrant sub-families (each represented only by a single genus), the tails are thick, and more or less approach those of the sharks.

(152.) The barb, sting, or spine, — for it has been called by all these names, — with which the tail of the majority of the sting and eagle rays is armed, is a most formidable weapon, in the shape of a long-headed lance: it is acutely pointed, and varies in length according both to the species and the size of the individual: it is a compressed, hard bone, having the two edges finely serrated, with the serratures pointing to the head, so as to tear the flesh upon being drawn out; and it thus inflicts a most grievous wound. It is currently understood by all sea-faring people, that these barbs are poisonous;

and so firmly is this believed by fishermen, that upon catching any of these sting rays, they immediately proceed to cut off the tail of the fish, or mutilate the spine. The use of the long naked tail, seen in most of these fish, is probably to twine round their prey, so as to confine its struggles. Sometimes there are two of these barbs placed close together; but in some of the sub-genera, both are absent.

(153.) The first, or typical, sub-family, containing the true rays, is eminently distinguished from all the others, by the pectoral fins being united to the snout in such a manner as that there is no interval of separation between them. All our British species, including the thornbacks, skates, &c., are of this description, and afford perfect examples of the general form pervading the whole of this division: in other respects, there are many variations. The group, indeed, is so numerous in its contents, that we may even distinguish the genera, which we shall now enumerate. The trygons, or sting rays (*Trygon* Antiq.), divide themselves into three genera. The first is *Trygon*, where the breadth of the body and pectorals is about equal to its length: the tail is armed with one or two spines, or stings, as they are called, at the base; and there is a narrow fin, either above, or below, or on both sides. *Pastinaca* Antiq.* differs from *Trygon* only in having the tail entirely naked: the common sting ray of the Mediterranean is the type of this genus, to which we prefer retaining the name by which it was known to the ancients. In two others, described and figured as natives of the Indian seas by Dr. Russell, the body is somewhat more oval than in the Mediterranean species, and there are two spines; but the number of these do not appear to indicate generic groups; and it not unfrequently happens that, in such as really possess two spines, one is accidentally broken off. The presence or absence of fins

* *Himantura*, Muller and Henle.

upon the tail, therefore, appears to us a more certain mark for discriminating the two typical genera of *Trygon* and *Pastinaca*, than the number of the stings; and this view, we perceive, has been taken by Muller and Henle. In further proof, also, we may refer to the two species above mentioned, from India: both are of the same form, and both have the tail entirely naked; yet in one there is but a single spine, while the other has two. The third genus is that of *Pteroplatea*, — a name given by the last mentioned ichthyologists to certain sting rays, which have the pectorals so very long as to render the breadth of the fish considerably more than its length: the tail, like that of *Pastinaca*, is always naked, but it is also remarkably short. It is here that the stings begin to disappear; for although one species of those which have been described possesses two, yet in another, from India (Russell, pl. 22.), there is none whatever. This latter fish, therefore, brings us near to the genus *Raia* (*R. rubra*, fig. 18.), as now restricted and understood by the moderns. This group, indeed, has recently been divided into several sub-genera; but as the value of these remains to be determined by a philosophic analysis of the real types, we do not, at present, adopt them. The whole may be characterised as diamond-shaped fishes, almost always covered with prickles or minute asperities, but never having the tail armed with a barbed spine, as in the three preceding genera: the tail, moreover, terminates in a small caudal fin; immediately

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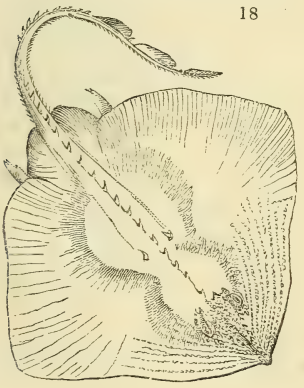

before which, on a line with the back, are two small dorsal fins: one of these latter, or the small caudal, may be expected to disappear in such aberrant species as approach *Pteroplatea* on one side, or go off, on the other, to *Anacanthus* Ehremb., — a genus which is stated to resemble *Trygon* in every thing but the possession of a sting. We are thus enabled to trace a circular disposition of the whole sub-family; the contents of which represent all the primary types of the cartilaginous order.

(154.) The second sub-family contains the gigantic *Pterocephalinæ**, or eagle rays. These are the fish which we have already mentioned as often growing to such an enormous size, and being as dangerous to man as the sharks. The form of their body is much like that of the sting rays, but with this difference,—that the pectoral fins are not continued so as to encircle the fore part of the head, which is consequently free; and the eyes are inserted at the edge of, not within, its circumference. The tail is as slender as in the last group, and is generally armed with a formidable barb or sting at its base; in addition to which, there is usually a small triangular dorsal fin placed at the base, which is very different from the long and narrow fin-like membrane seen towards the end of this part in many of the sting rays. Although the species are by no means so numerous as in the last, we yet find five divisions, so well characterised by their general form, that we shall adopt them on the present occasion. These gigantic fish are very rarely seen, and then chiefly in warm latitudes: they seem, indeed, to be pelagic, for they are seldom taken near any shore.

(155.) We place *Myliobates* as the first genus, because it has a closer affinity to the typical rays than any of the other four; this is shown by its resembling *Pteroplatea* in being much broader than long, owing to the great

* These constitute the genus *Cephaloptera* of Dumeril; but as that name, unluckily, had been previously given by Geoff. Saint-Hilaire to a remarkable genus of birds, we propose to substitute the present for it.

development of the pectorals: these fins, however, only take their commencement immediately behind the eye; so that those and the snout are entirely free. The tail of these fish, of which one species is well figured among the Indian fishes of Russell, is very slender and excessively long, being near twice the length of the body; and it is described as being without any sting or bony process. Whether this weapon is constantly absent in certain species, or whether, as on the present occasion, it had been broken off accidentally or purposely, (for it is universally considered by fishermen of all countries to be poisonous,) is a question which must be undecided; certain it is, however, that some of the rays, both in this and the last sub-families, appear to be totally devoid of a sting. The next genus is *Rhinoptera* of Kuhl. In this the head is equally free; but the snout is so deeply cleft in front, that in some species it assumes the aspect of two horn-like protuberances, not in substance, but in shape. In one species, the *R. quadrilobata* of Le Sueur*, here represented from an exquisite plate by that naturalist (*fig.* 19.), there are two other processes, one on each side the under part of the snout (*a*), which are obviously the first development of those fin-like paddles seen in the next genus. The mouth, both of this and *Myliobates*, is placed underneath (*b*); but the sting does not appear constant: it exists in the species here figured (*c*), but

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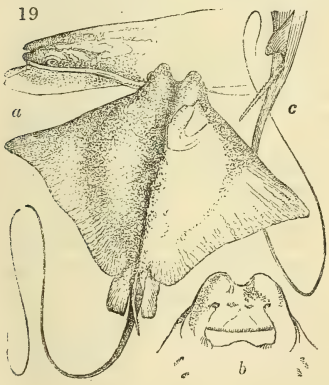

* Amer. Trans. vol. i. pl. 20.

is absent in that described by Dr. Russell. The two processes just mentioned conduct us at once to the genus *Ceratoptera* M. and H., where these appendages assume the form and office of lobed fins, as represented by the same artist (*fig.* 20.), the head is completely

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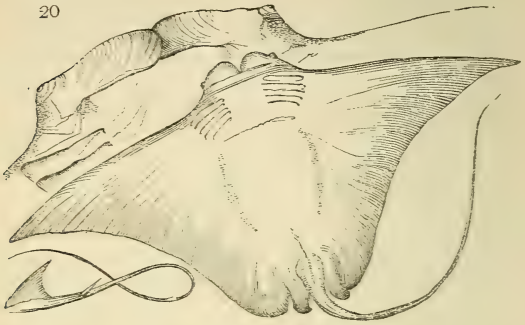


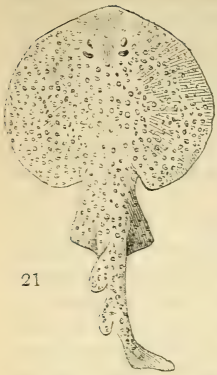
obtuse in front, without any of the lobed appearance seen in the last genus; while the mouth is at the termination of the muzzle. On this latter account, these remarkable fishes have been justly separated from the true *Pterocephali* (or the *Cephaloptera* of Dumeril), where the mouth is on the under side of the head, as in all the other genera. We place *Ætobates* M. and H. as the last genus, with some hesitation, suspecting that it really possesses this rank in the present division; for it has every one of the characters of *Myliobates*, superadded to a caudal sting. But its most remarkable peculiarity is the circumstance of the jaws being dissimilar: "the lower one," as Dr. Russell observes on a species he has described, "being arched, narrow, and projecting beyond the wider immovable upper jaw: the edges of both are smooth and without teeth."* MM. Muller

* Coromandel Fishes, vol. i. p. 5.

and Henle, however, whose method is chiefly founded on these organs, gives the generic character to this group of having one row of teeth in each jaw. We believe that both these accounts, however apparently conflicting, may be essentially correct, when applied to different species; and this only adds another to the numberless instances that may be cited of the subordinate value which such dental characters possess, when employed generically.

(156.) The torpedo rays appear to follow next in the natural series. These fishes have long acquired celebrity from the powers of electricity they possess; while their shape is so remarkably singular, that they appear more like gigantic tadpoles than fish: the head seems of an enormous size, owing to its being completely surrounded by the pectoral fins; which latter, from not being angulated, as in the other rays, make the head appear, in some species, completely circular: so far, indeed, the general structure is in much accordance with the last two sub-families; but now the tail begins to assume the usual shape of other fishes; although not longer than the head and body, it is thick and fleshy, terminated by a distinct caudal fin, and bearing above it two dorsals: but all these three fins are much smaller than the ventrals; these are triangular, and placed on each side the vent, which is in the middle of the fish. The situation of the eyes, the mouth, and the branchial spiracles, is precisely the same as in the thornbacks.

(157.) The torpedos appear to be of many species, and to inhabit the seas of nearly all temperate and tropical latitudes. As we cannot well pass over the extraordinary properties of these fishes, and yet cannot speak of them from our own observation, the reader will understand that the following account is abridged from the best authors who have written upon the subject. The form of the electric torpedo is much the same as that of the spotted Indian species (*fig.* 21.): the size, of course, varies; its general length is about two feet;



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but one mentioned by Pennant was nearly four, and weighed fifty-three pounds: the colour of the upper surface is different shades of brown, sometimes marked with obscure ocellate spots; the under surface is whitish or flesh-coloured. Like others of this family, the torpedo seems to lay in wait for its prey, partly buried in the sandy bottom of the sea; and this is effected by the animal quickly flapping all its fins, so as to cast the surrounding sand partially over its body. According to Pennant, it preys upon surmullets, plaice, &c., which have been found in their stomach: in what manner, however, these swift swimming fish are caught — whether by a sudden dart of the torpedo from its ambush, or by exerting its electric faculty — must remain undetermined. Before detailing the effects of this power, we shall give the reader the following abstract of Dr. Hunter's description of the organs which produce them.

(158.) The electric organs constitute a pair of galvanic batteries, disposed in the form of perpendicular hexagonal columns, placed on each side of the head and gills, from whence they extend to the semicircular cartilages of the pectorals; within these limits they occupy the whole space between the skin of the upper and of the under surface: they are thickest at the edges, near the centre of the fish, and become gradually thinner towards the extremities. Each electric organ, at its inner longitudinal edge, is a convex elliptic curve; each is attached to the surrounding parts by a close cellular membrane, and also by short and strong tendinous fibres, which pass directly across from its outer edge to the semicircular cartilages; and they are covered, above and

below, by the common skin of the animal, under which there is a thin fascia spread over the whole organ. This fascia is composed of fibres, which run longitudinally, or parallel with the back: these fibres appear to be perforated in innumerable places, which gives the fascia an appearance of being fasciculated: its edges, all round, are closely connected to the skin, and at last appear to be lost, or to degenerate into the common cellular membrane of the skin. Immediately under this is another membrane, exactly of the same kind, the fibres of which, in some measure, decussate those of the former, and pass from the middle line of the body outwards and backwards: the inner edge of this is lost with the first membrane; the anterior, outer, and posterior edges are partly attached to the semicircular cartilages, and partly lost in the common cellular membrane. This inner fascia is continued into the electric organ by many processes, and thereby makes the membranous sides or sheaths of the columns, which are presently to be described.

(159.) Each organ is about five inches in length, and at the posterior end three in breadth, though it is but little more than half as broad at the posterior extremity; each consists wholly of perpendicular columns, reaching from the upper to the under surface of the body, and varying in their lengths according to the thickness of the body. The shape of these columns, also, is very variable; the greater number are either irregular hexagons, or irregular pentagons: their coats are very thin, and closely connected with each other, having a kind of loose network of tendinous fibres between the columns, which they unite more firmly; and this purpose is further effected by strong unelastic fibres: the number of these columns, in different torpedos of moderate size, appears to be about 470 in each organ, but in a very large individual they were 1182; they must, therefore, increase, both in size and number, with the growth of the animal. Each column is divided by horizontal partitions, which appear to contain a fluid: they are not totally detached from each other, for they sometimes

adhere at different places, by blood-vessels passing from one to another: the number of these partitions in a column one inch in length, appeared to be 150; this proportion was so regular in several individuals, that it seems, as the fish grows, new partitions are added to the extremity of the column from the fascia: the partitions are very vascular. The arteries are branches from the veins of the gills, which convey the blood which has received the influence of respiration: they pass, along with the nerves, to the electric organ, and enter with them; they then ramify in every direction. The veins of the electric organ pass out close to the nerves, and run between the gills to the heart: the nerves inserted into each electric organ, arise from three very large trunks placed on the lateral and posterior part of the brain, and then ramify in every direction between the columns.

(160.) The number and magnitude of the nerves, bestowed upon these organs, in proportion to their size, must, on reflection appear as extraordinary as the phenomena they afford. Nerves are given to parts either for sensation or action: if we except the more important senses of hearing, seeing, tasting, and smelling, which do not belong to the electric organs, there is no part, even of the most perfect animals, which, in proportion to its size, is so liberally supplied with nerves; nor do the nerves seem necessary for any sensation which can be supposed to belong to the electric organs; and with respect to action, there is no part of any animal, however strong and constant its natural action may be, which has so great a proportion of nerves. If it be, then, probable that those nerves are not necessary for the purposes of sensation or action, may we not conclude that they are subservient to the formation, collection, or mana gement of the electric fluid? especially as it appears evident, from Walsh's experiments, that the will of the animal does absolutely control the electric powers of its body, which must depend on the energy of the nerves.

(161.) The effects produced by this highly singular organisation were well known to the ancients; but they — being ignorant of electricity, and prone to invest every uncommon operation of nature with an air of mystery — attributed these shocks to magic, at least, if we may believe some of their poets; and Pliny, whose credulity was excessive, affirms that the torpedo, even when touched with a spear or stick, can benumb the strongest arm and stop the swiftest foot. The celebrated Redi, in the 17th century, contributed greatly to dissipate these exaggerated notions, by elucidating much of the true history and structure of this wonderful fish; but our learned coutryman Walsh, by a series of experiments made before the Royal Society, was the first who proved that its powers were truly electric. The effects of the torpedo (he observes) are absolutely electrical, forming its circuit through the same conductors with electricity, and being intercepted by the same non-conductors, as glass and sealing-wax. The back and breast of the animal appear to be in different states of electricity; by a knowledge of which circumstance, we have been able to direct his shocks, though they were small, through a circuit of four persons, all feeling them; and also through a considerable length of wire held by two insulated persons — one touching the lower surface of the fish, and the other the upper. When the wire was exchanged for glass or sealing-wax, no effect could be obtained; but as soon as it was resumed, the two persons became liable to the shock. Numberless experiments of this sort determined the choice of the conductors to be precisely the same in the torpedo as in the Leyden phial; while the sensation occasioned by one and the other, to the human frame, are precisely similar. It is remarkable that the torpedo, when insulated, is able to give us, insulated likewise, forty or fifty successive shocks from nearly the same part, and with little or no diminution of force; and these are so rapid, that Mr. Walsh says he had taken no less than fifty in succession from an insulated torpedo, in the space

of a minute and a half. All these experiments confirmed the belief that the electricity of this fish is condensed, in the instant of its explosion, by a sudden energy of the animal: the effect appears to arise from a compressed elastic fluid, restoring itself to its equilibrium in the same way, and by the same media, as the elastic fluid compressed in charged glass. Notwithstanding the weak spring of this electricity, Mr. Walsh was able to convey it through a circuit formed from one surface of the animal to the other, by two long brass wires and four persons; which number, in some of the experiments, was increased even to eight: every person was made to communicate with each other, and the two outermost with the wires, by means of water contained in basins properly disposed between them for that purpose. It will be unnecessary to follow Mr. Walsh's more minute details of these experiments; and, after all, he observes that the effects produced on these occasions by the torpedo, resembled, in every respect, a weak electricity. It was further ascertained that the shocks were much stronger when the fish was taken out of the water than when it was emerged in it; or, as our author observes, "the shocks in water appeared, so far as sensation could decide, not to have near a fourth of the force of those that took place at the surface of the water, nor much more than a fourth of those given when the fish was entirely in the air, on being raised by the hand." Finally, we may observe that this power is possessed, not only by the young torpedo on its birth, but even while it is yet a fœtus in the body of the parent animal. This fact was ascertained by Spallanzani, on dissecting a torpedo in a pregnant state, and which contained in its ovarium several roundish eggs of different sizes, and also two perfectly formed fœtuses, which, when tried in the usual manner, communicated a very sensible electric shock; and this was still more perceptible when the little animals were insulated by being placed upon a plate of glass. The electricity of the torpedo is altogether voluntary; and sometimes, if the animal

is not irritated, it has been affirmed that it may be touched, or even handled (?), without being provoked to exert its electric power.

(162.) There can be no doubt that several species have been confounded under the common name of *Torpedo electrica*, which likewise possess the same properties; but whether all those of the same external form are likewise electric, is very uncertain. Two species evidently inhabit the British seas—one of which is spotted, the other not: both, however, are of rare occurrence. A specimen mentioned by colonel Montagu, taken off the coast of Tenby in Wales, weighed about 100 lbs.* It has been thought that the torpedo is a slow and inactive fish; and that, consequently, these powers have been given it for more readily procuring its food, by killing such small fish as pass near it. That this electric power is so used, as well as for a means of defence, is highly probable: but it appears to us that there is nothing in the structure of this fish to render it slow or inactive; on the contrary, the great development of the pectorals, and even of the ventrals, clearly shows that these fishes must be endowed with the power of swimming, for a short distance, with great rapidity,—fully as quick as any of the true rays or thornbacks. Nor do we think the following sensible observations of Mr. Couch militate against what we here advance:—"One well known effect of the electric shock is to deprive animals killed by it of their organic irritability, and, consequently, to render them more readily disposed to pass into a state of decomposition; in which condition the digestive powers more speedily and effectually act upon them. If any creature, more than others, would seem to require such a preparation of its food, it is the torpedo, the whole canal of whose intestine is not more than one half as long as the stomach." † Recently ‡, this genus has been divided

* Yarrell's Fishes, vol. ii. p. 411.
† Ibid. vol. i. p. 412.
‡ Muller and Henle's arrangement. Mag. Nat. Hist. No. xiv. p. 90.

into four sub-genera, the characters of which, however, do not appear in the paper alluded to.

(163.) We finally have resolved to place the genus *Squatina* between the torpedos and the snout rays (*Rhinobates*); by which situation it preserves its analogy to all those sharks which have, like this, the muzzle obtuse, and the mouth terminal. The annexed representation of *S. angelorum* (*fig.* 22.), found in our seas, will give

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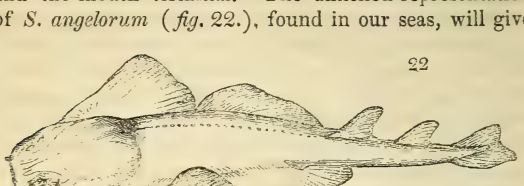
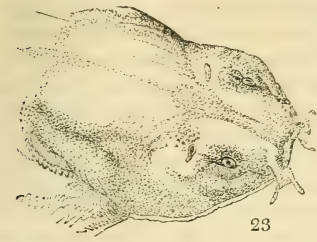


the reader a better idea of this singular fish, than a laboured description. Its whole aspect is certainly more like that of a ray than of a shark. The circumstance of the branchial apertures being placed beneath, joined with the very great development of the pectorals, and the flattened obtuse head (intermediate between that of a torpedo and a ray), all conspire to point out its natural station to be in the present family. The only character, in fact, which it seems to possess in common with the sharks, is that of having the tail fully developed, and the pectorals detached, in front, from the head: but these considerations are not sufficient, in our opinion, to counterbalance those just stated; to which may be added, the depressed form of the whole fish, which shows that its habits are naturally very much the same as those of all the rays. Cuvier refers the *Squalus aculeatus* of the Mediterranean to this group.—a fish we have not seen; and Le Sueur has beautifully figured another (*S. Dumerilli, fig.* 23.), which inhabits the coast of America: the shape, situation, and proportion of the two dorsals and of the caudal are precisely the same as what we see in

many of the torpedos. Of our British species Mr. Yarrell says, that it sometimes is caught of the weight of 100 lbs.; that it is very voracious, and feeds on the smaller flat fish, which, like itself, swim close to the bottom; occasionally, like them, also, hiding itself on the loose soft soil that floats over it. We cite this remark, because it is in further confirmation of our belief that the *Pleuronectidæ* represent the *Raidæ*, not only in the disk-like shape and compression of their bodies, but also in their food and modes of life.



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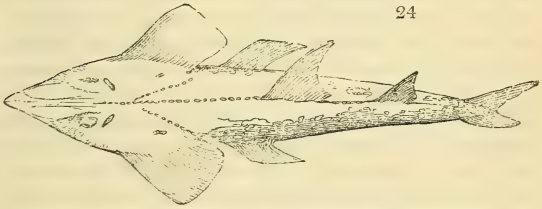
(164.) The third and last aberrant division of the rays is represented by the genus *Rhinobates*, of which the annexed cut of *R. Rüppellii* Sw. (*fig.* 24.) is a very



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good example of the whole. This group has also been divided into five sub-genera, of which there is only one species in each; but the characters appear to us so slightly defined, that we cannot at present adopt them. Nevertheless, one of them, named *Platyrhina* M. and H., is described as having "the body orbicular;" in which case it is much more probably a sub-genus of the *Torpedinæ* than of the present group; an orbicular body being one of the primary distinctions of those fishes. Certain it is, however, that the typical form of the sub-

family now before us, is to have the snout considerably elongated, and the body and tail more resembling that of the true sharks, than any of the other rays; in other words, it has the head of some of the long-snouted rays — such, for instance, as the *Raia chagrinea* * Penn. — placed on the body of a shark. None of these fishes have been found in the northern seas, nor are we acquainted with any from the Mediterranean; several, however, occur in the Red Sea, and on the shores of India, of which representations will be found in Rüppell's, Russell's, and Hardwick's collections of figures. The sub-genus *Rhina* probably belongs to the *Torpedinæ*, since it has the muzzle short, large, and round, instead of lengthened and pointed.

(165.) The circular succession of the *Raidæ* is thus seen to be all but perfect, since the only intervals in the chain occur between *Squatina* and the two types on each side of it — *Torpedo* and *Rhinobates*. It is clear that *Rhinobates* is but the incipient form, as it were, of the saw-fish; and as these latter have always been regarded, and justly, as coming within the confines of the *Squalidæ*, we must place *Rhinobates* as the last of the *Raidæ*. We have no means of judging, either from specimens, or a good figure and description, of the true nature of the *Squalus aculeatus*, which Cuvier refers to the *Squatinæ;* — Does it really belong to that genus, or to a different type among the *Squalidæ?* In either case, its spined back shows its direct relation to the thornbacks (*Raia*); while its terminal mouth indicates the same with regard to *Squatina*, *Cestracion*, &c., and the other chironectiform types. Under the belief, therefore, that the above series is the natural one, we shall at once proceed to investigate the analogies resulting from this view of the *Raidæ*, by comparing the divisions with those of a

* This species may be cited as an additional instance of the insufficiency of arranging the cartilaginous, or, indeed, any other fishes, upon a primary regard to their teeth: for not only do these organs vary in different species, and in the very same individual at different ages, but actually in the sexes: the blunt tesselated teeth of the *Raia chagrinea* become pointed in the adult male, while in the female they never alter.— See Yarrell, vol. ii. p. 416.

higher denomination, under which we have placed the whole of the cartilaginous fishes.

Analogies of the RAYS *to the* CARTILAGINOUS FAMILIES.

Sub-families of the RAYS.	*Analogical Characters.*	Families of the CARTILAGINES.
Trygoninæ.	Head surrounded with the pectoral fins.	RAIDÆ.
Pterocephalinæ.	Head distinct from the pectorals.	SQUALIDÆ.
Torpedinæ.	Fore part of the head excessively broad.	POLYODONIDÆ.
Squatinæ.	Mouth protractile, and furnished with cirri.	STURIONIDÆ.
Rhinobatinæ.	Body much lengthened.	CHIMÆRIDÆ.

We must, in the first place, remind the reader of the arguments already used in proof that the cartilaginous order of fishes corresponds to the natatorial order of birds, where the wings are universally more developed than in any other type. Now, in proof that this analogy is true, we see that the pectoral fins, which correspond to the wings of birds, are more developed among the rays than in the sharks; and thus we find not only that the *Raidæ* stand at the head of the cartilaginous order, but that the *Trygoninæ,* from having the pectorals so much developed as to surround the snout, become pre-eminently typical — and being so, are the representatives of their whole family. The eagle rays and the sharks, again, stand opposite each other; and we discover an analogical character, in the head of both being distinct from the pectorals. It is evident, that, in whichever family we place *Squatina,* it is analogous to the sturgeons, and to the cirrated sharks; for these are the only cartilaginous fish which have cirri to their jaws; and if Cuvier is correct, that the *Squalus aculeatus* is a *Squatina,* we shall have another point of strong resemblance to the sturgeons, which are universally armed with prickles. The broadest snouts among the rays are seen in the torpedos; and the broadest, as well as longest, in all the cartilaginous families, is in the genus *Polyodon;* both being the fissirostral

types of their own proper circles. The snout rays, again, are the longest, in their bodies, of the *Raidæ* — a character, likewise, which more especially belongs to the northern *Chimæra* among the sharks; so that the analogies between both become complete; and the series of affinities, in which we have placed the groups, is doubly corroborated by the series of analogies occurring in precisely the same order.

(166.) The rays, properly so called, is the only one of all the divisions of the family whose types are sufficiently made out to show a circular series; being the most typical, it is, as usual, very full of species, and the variety of forms is accordingly proportionate. From ignorance, however, of their manners, and of very many other points in their structure (which we may hope the two learned naturalists now engaged on these fishes will clear up), we cannot trace their analogies, in one instance, so perfectly as could be wished; but all the others are so remarkable strong, that we have no hesitation in laying the following table before the reader:—

Analogies of the TRYGONINÆ *and the* RAIDÆ.

Genera of the TRYGONINÆ.	*Analogical Characters.*	Families of the RAIDÆ.
Trygon Antiq.	Tail with narrow fins.	TRYGONINÆ.
Pastinaca Antiq.	Tail without any fins.	PTEROCEPHALINÆ.
Pteroplatea M.,H.	Muzzle broad and very obtuse.	TORPEDINÆ.
Raia Linn.	Back often armed with spines.	SQUATINÆ.
Anacanthus.	Snout produced: no spinal process on the tail.	RHINOBATINÆ.

The division we have formerly made between those sting rays which have a fin either above or below their tail, and those in which all vestige of fins disappear, now turns out to be precisely one of the leading discriminations between the two great divisions of the sting rays, and the eagle rays; all the latter having the termination of the tail quite naked. The thornbacks, and the other rays, find their prototypes in Cuvier's *Squatina aculeatus;* these groups, in fact, being the only ones

wherein the back is furnished with spines. The genus *Anacanthus*, as its name imports, contains those rays which have the character of *Trygon*, but without their sting: the snout, also, if we rightly understand the genus, is produced; so that it becomes at once analogous to the *Rhinobatinæ*: it is this genus, however, upon which, not having had the means of examining, a slight doubt may arise; but the connection of the *Trygoninæ* to the *Rhinobatinæ* is so unquestionable, that it matters very little to our present purpose, upon which link in the chain we fix for a type, supposing *Anacanthus* not to be one. We need not pursue this subject further, because these analogies carry with them numerous others, and will enable the reader to pursue the subject through all the chief groups of the class.

CHAP. VII.

ON THE PLECTOGNATHES, OR CHELONIFORM ORDER.

(167.) The order now before us, notwithstanding the diversity of characters it presents as a whole, may, nevertheless, be pronounced one of the most natural in the whole ichthyological circle. Under the name of the *Branchiosteges*, it was so considered by Artedi; and although that great father of our science did not detect the concealed nature of the operculum, yet his views of the true extent of the group appear to be more just and comprehensive than those of the moderns. Our own opinions, at least, are more in unison with those of Artedi, who includes in this division the genera *Cyclopterus* and *Lophius*. M. Cuvier, on the contrary, confines it entirely to the *Balistidæ*, or cheloniform genera

(*B. ornatissimus, fig.* 25.), which constitute his order

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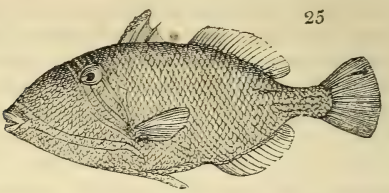

Plectognathi: this name, however, we retain, since, by the anatomical investigations of this eminent naturalist, the true nature of the gills were first made known. The most general characters belonging to this group will now be noticed in the order of their prevalence. In the first place, they are universally destitute of true or imbricate scales: the body is soft and naked, as in the *Chironectidæ*, or frog-fish; or it is hard and coriaceous: in the *Balistidæ*, or file-fish, the skin is hard, and scored * into diamond-shaped patterns (*fig.* 26.): when magnified (*a*), the granulations are distinctly seen, the interstices being smooth. In others, the body is either covered with spines, or incased with bony plates, the sutures of which fit to each other, and do not, as in ordinary fishes, lay in an imbricate or tile-like manner upon each other. The skeleton is neither strictly osseous, nor cartilaginous, but is a mixture of both structures; presenting a gradation from the soft and cartilaginous structure to that which is hard and truly osseous: the assertion, therefore, that its "entire general structure is that of ordinary fishes," is not borne out by fact; since M. Cuvier himself acknowledges, that, in the majority, the bones are semi-

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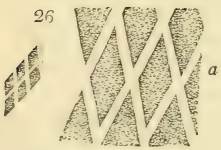

* Scored or reticulated: we use this term to denote the peculiar reticulated markings on the shagreened skin of certain *Balistidæ*, which give them, at first, the appearance of possessing diamond-shaped scales.

cartilaginous, or that they take a long time to harden; and that, in all, "very small vestiges of ribs are to be found." The third is an equally important character: the operculum and branchia, indeed, exist; but in a very imperfectly developed state, when we compare them with those of ordinary fishes; and they are altogether concealed by being covered with the thick skin of the body, which only leaves a small cleft, or spiracle, by which the water taken into the mouth escapes. Hence they breathe, like the *Cartilagines* and the apodal order, by spiracles. The other characters of the group are secondary, because they serve more to determine the family divisions, than to characterise the entire order. In the *Balistidæ*, or tortoise-fishes, the maxillary bone is soldered to the intermaxillary, which alone forms the jaws, and to which the palatine arch is united by a suture with the skull, so that it possesses no power of motion; the mouth is thus most imperfect, and is always very small. In another typical group, the eyes are also very small, but are placed almost vertically: the pectoral fins are very large, and often have some resemblance to feet, being placed on a sort of peduncle, which enables these frog-fish to crawl upon the ground: the mouth opens upwards, and the lower jaw is longest. In one group only—the most aberrant of all—is there a variation in the branchia, indicating an affinity to the class of animals which next succeed, namely, the *Amphibia*.

(168.) Thus characterised, as a whole, the *Plectognathes* appear to arrange themselves into the following natural families:—1. The *Balistidæ*, or cheloniform fishes, having the body oval or round, and almost always covered with osseous plates or armed with prickles: 2. The *Chironectidæ*, or frog-fishes, where the pectoral and ventral fins, particularly the former, assume the appearance of feet; the body being thick and smooth: 3. The *Lophidæ*, having the head enormously large and greatly depressed: and, 4. The *Sygnathidæ*, of a long serpent-like shape, covered with hard plates, and the

muzzle excessively long. The contents of these divisions are very unequal; and it will be seen that, from the absence of a fifth type, they do not form a circular group: but this is a matter of inferior moment; since it will subsequently appear that the four, above named, find their representatives in four of all the other ichthyological circles. It may here be observed, that very few of this order are found in the European seas, and that none of them are esteemed as food.

(169.) The family of *Balistidæ*, or cheloniform fishes, is the most interesting, as it is the only one in which any vivid colouring is found; many of the species, indeed, are remarkably beautiful: neither is the form, in general, devoid of symmetry. They are very numerous in tropical seas, and present many modifications of form, which have not yet been accurately defined and arranged; but only one species (the *Capriscus Rondeletii* of our celebrated Willughby) occasionally wanders to our coasts. Having paid much attention to this interesting family, we are enabled to determine, as we believe, the five sub-families. The two first are the *Ostracinæ*, or trunk-fish, and the *Balistinæ*, or file-fish: these we regard as typical: they are distinguished by having the body covered with angulated plates, or hard and reticulated skins; the mouth being furnished with real teeth. The three aberrant sub-families are the *Tetradoninæ*, or hare-fish; the *Diodoninæ*, or globe-fish; and the *Cephalinæ*, or sun-fish: the circular succession of these groups into one is effected by the *Orthagoriscus oblongus**, whose hard skin is divided into those angular compartments which is the peculiar characteristic of the *Ostracinæ*. We shall now collect together the few points of general interest that are at present known respecting these groups; and then compare them, in their analogical relations, with others. They have hitherto been much neglected, even in the latest systems; and this will account for our not being

* Bl. Sch. pl. 97.

able, in the synopsis, to determine many of the subordinate forms.

(170.) The *Balistinæ*, or file-fish, are not so grotesque in their general form as the diodons and tetraodons, and are much more beautiful fish: the colours are generally rich and vivid, and the body is not armed with spines (*B. erythropterus, fig.* 27.).

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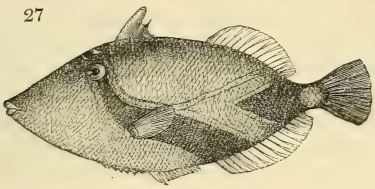

The greatest number are confined to the still waters of tropical seas, and principally those of India and America. A very singular circumstance connected with this species has given rise to the name now applied to the whole group. The typical *Balistes* have two dorsal fins, one of which is fronted with a strong bony spine. Salviani was the first to discover that the bones or rays of this fin are so contrived as to act in concert, with considerable force, in suddenly elevating the fin at the pleasure of the animal: though the foremost or largest be pressed ever so hard, it will not stir; but if the last or least ray of all be pressed but very slightly, the other two immediately fall down with it, as a cross-bow is let off by pulling down the trigger. For this reason, the fish is called at Rome *Pesce balestra*. These fish are provided with true teeth, of which eight are in each jaw. There are no true ventral fins; but, in most, the bone of the pelvis is prolonged beyond the skin, and is even furnished with bony rays connected by a membrane, so as to constitute, in effect, a true ventral fin.

(171.) We arrange the *Balistinæ* under five prin-

cipal divisions or genera; and these include several distinct modifications of form, which take the rank of sub-genera. The great number of species, however, which swarm in the Indian and Pacific Oceans, will considerably augment these minor groups, when their peculiarities of structure are better understood.* The two first, or typical genera, are *Balistes* proper, and *Capriscus*, a name employed by Willughby and the old writers to designate some of these fishes, and which will be preferable, on that account, to a new one of our own: both these are distinguished by having the body covered with large diamond-shaped divisions, scored, resembling network, separated from each other by a suture, as if the hard skin had been regularly scored: hence their bodies may be termed mailed and tessellated. In *Balistes*, the tail is armed with three or more rows of acute prickles, or lancets, which are entirely wanting in *Capriscus* (*C. velata*, *fig.* 28.): each of these, again,

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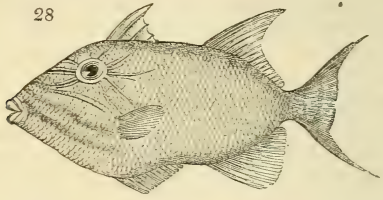

contain several sub-genera, readily distinguished in the different forms observed in the first dorsal and the caudal fins, and in the structure of the pelvis.† The aberrant genera, as usual, contain fewer variations of form; all three, however, are at once separated from the typical groups by the scale-like reticulations on their body,

* Having long prosecuted, at intervals, a particular analysis of this family, with drawings of all the species we can procure, we beg to solicit from those of our readers who have the means of assisting us, preserved specimens (either dried or in spirits); and, more especially, the loan of coloured sketches or drawings made from the life: we make the same request in regard to the chetodons, and the silures (*Siluridæ*).

† The arrangement of M. Cuvier, founded upon the number of rows of ancets on the sides of the tail, is obviously artificial, and otherwise objectionable, particularly as the above characters are entirely overlooked.

above mentioned, being either very minute, or the skin only granulated. These genera have been already named by Cuvier, *Alutera*, *Triacanthus*, and *Monocanthus*. In this latter genus, some of the forms, as that of *Mon. bifilamentosus* Less. (*fig.* 29.), are singularly grotesque; but the sub-genera have not been investigated, and much remains to be done in determining their location: some will, doubtless, enter as aberrant types in the other genera; nor is it at all probable that the genus *Triacanthus* should contain only one typical example. If the ichthyologist wishes to study the relations of all these new divisions, he will find they follow each other in the same series as that in which we have noticed the primary families of the entire order. The analogies, indeed, of the whole of this family, to that of the *Chætodonidæ*, with which so many writers have incidentally compared them (one of the best proofs of the analogy being natural), are most particularly beautiful. But we have no space for this inviting subject.

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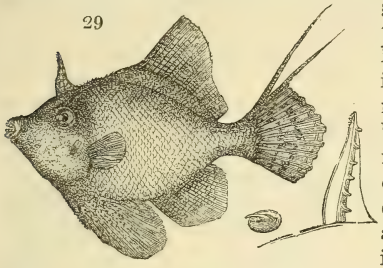

(172.) The sub-family *Ostracinæ* is composed of the trunk or tortoise fish (*O. argus* Rüpp., *fig.* 30.); so called

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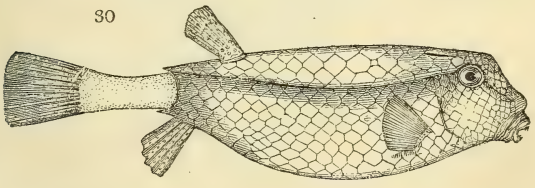

from their bodies being often quadrangular like a trunk or

box, and from the plates by which it is covered resembling, in shape, those of the chelonian reptiles, or tortoises. They are all fish of a small or moderate size, with rather large eyes; but very small mouths, armed with a few conical and real teeth: so different is their internal structure from that of the osseous fishes, that M. Cuvier confesses that the greater portion of their vertebræ are cemented together; and the ribs exist only in a rudimentary state. They have no ventral fins, and they have but one dorsal. This evident inferiority to the *Balistinæ* at once shows them to be the sub-typical group. Some of the species are furnished with horn-like protuberances, giving them a very grotesque appearance; and all are so compactly covered with the impenetrable and immoveable cuirass of the body, that they have only the power of moving the tail, the fins, and the thin lips of their little mouth. Most of the species are found in the Indian seas.

(173.) We now come to the aberrant group, composed of the *Tetraodinæ*, the *Diodoninæ*, and the *Cephalinæ:* these three are distinguished from the former by having no true teeth, these processes being supplied by certain lamina of an ivory substance placed inside of the jaws.* They are also entirely destitute of the squamular plates; their body being covered with a simple skin, which is either rough or beset with spines. In other respects they have a general resemblance, both in shape and structure, to the other cheloniform fishes; the dorsal fin, however, is invariably single. A prejudice against eating these fish seems to be prevalent in all the countries where they are found, and also a general belief that most of the species are poisonous.

(174.) The *Tetraodinæ* †, or hare-fish (*Tet. diade-*

* M. Cuvier remarks, that these laminæ of the jaws are essentially true teeth, united together and succeeding each other as they are successively worn out by the effect of triturition. If this be true, which there seems no reason to doubt, it reveals an absolute point of analogy to the gliriform quadrupeds, where the cutting teeth are renovated nearly in the same manner.

† It seems advisable to designate this group as the *Tetraodinæ;* the *Tetraoninæ* being a sub-family of rasorial birds.

matus Rüpp., *fig.* 31.), have acquired this name from the sharp edges of the jaws being divided in the middle,

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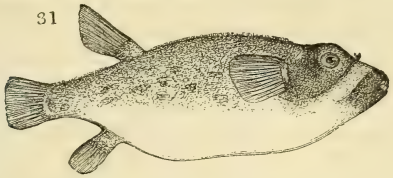
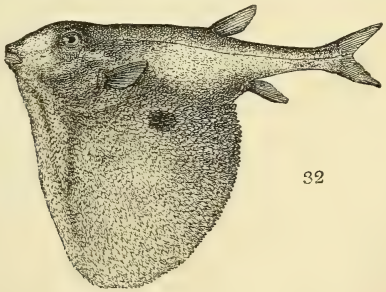


so as to present the appearance of four teeth — two above, and two below; and this structure also gives them a remote analogy to the lips of the hare. The tail is more lengthened than in any other of the cheloniform fishes, in accordance with what we should expect in the apodal type: the spines on the body are so short, that they are mere prickles; while, in some, they merely assume the appearance of rough asperities on the skin; the body is nevertheless, very slimy.* These fishes are remarkable for having only three gills or branchia on each side, — a structure which prepares the passage from the *Balistidæ* to the *Chironectidæ*, where the number is precisely the same. The rays of all the fins, except the caudal, are covered by a thick skin; and all the species have small mouths with fleshy lips. The food of all these small-mouthed fishes appears to be crabs and shell-



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* Hamilton's Gangetic Fishes, p. 5.

fish, which they grind with ease by means of their strong enamel jaws or hard teeth. As a passage from this to the next sub-family, we arrange the singular shaped *Triodon bursarius* Reinw. (*fig.* 32.), for it partakes of the general structure both of one group and the other.

(175.) The *Diodoninæ*, or globe-fish, have the jaws not only destitute of any apparent teeth, but are even without any divisions, so that each remains as one entire piece; yet behind their cutting edges, however, is a slightly rounded protuberance, marked by regular furrows, which supplies the place and office of grinding teeth: the form of the body is more globose than in any of this order; and, when distended, becomes, in some species, absolutely round: they are all armed with numerous long and acute spines, of which, as M. Cuvier observes, a horse chestnut is a good miniature resemblance. These fishes are confined to the tropical and warm latitudes, chiefly of India; and none seem to exceed a very moderate size. The gills are five in number, and are very slightly developed. The globe-fish, as well as the tetraodons, are remarkable for the power of inflating their body like balloons, to an enormous size, by swallowing the air, and thus filling their stomach. This is obviously a means of defence against their enemies: M. Cuvier, indeed, remarks, that, when thus inflated, they turn topsy-turvy, the stomach being uppermost, and they float to the surface, without being able to direct themselves. This, however, seems somewhat improbable, and by no means according with what we should naturally expect from fish so well provided with the means of actively repelling their enemies. The following account of the *Diodon histrix* L., by Dr. Hamilton, seems a much more natural relation of its habits. "This fish is said to afford an amusing spectacle when taken by a line and hook properly baited with some small crab or other crustaceous animal: after having played round the bait for some time in various directions, it seizes it with a sudden spring; but finding itself hooked, it exhibits every appearance of the most violent rage, inflating its

body and elevating its spines to the highest possible degree, as if endeavouring to wound in all directions; till, after having tired itself by its vain efforts, it suddenly expels the air from its body, and for some time becomes entirely flaccid. When drawn towards the shore, however, it redoubles its rage, and again inflates its body; in this state it is left on the sand, it being impossible to touch it without danger till it is dead."

(176.) The *Cephalinæ*, or sun-fish, are a most singular group: they grow to an immense size, and look more like the dissevered head of a fish, than the entire animal itself. There are but few species yet determined, only one of which (*Cephalus brevis*) is found in the European seas. It grows to a vast size, having been said to reach the length of eight or even ten feet, and the weight of 500 lbs.: it is sometimes observed to lie on its side on the surface of the water; on which occasions it may be captured without difficulty. The false teeth and mouth very much resemble those of the diodons, — the former being undivided. M. Cuvier affirms that it is destitute of an air-bladder; in which case it probably swims at the bottom of the ocean. A new genus of these fishes, *Pedalion gigas* Guild* (*fig.* 33.), of gigantic size, inhabiting the West Indies, will be subsequently described. The sun-fish are supposed to feed principally on crabs and shell-fish; and they are known to exhibit, during the night, a high de-

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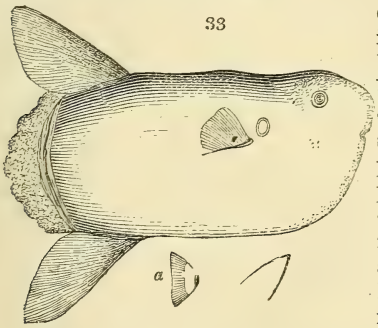


* The late and lamented Lansdowne Guilding, who, to the regret of science, fell a victim to the ardour of his researches in the island of St. Vincent.

gree of phosphoric splendour. The skin is not armed either with spines or prickles, but is nevertheless very rough; nor can these fish dilate their stomach.

(177.) Before proceeding further, let us see what results attend this new distribution of the cheloniform family, by comparing the several divisions, all of which have been instituted long ago, and adopted by M. Cuvier, although in a different series to that in which they now appear. We shall place, therefore, the sub-families in one column, and the primary orders of fishes in another.

Analogies of the BALISTIDÆ, *or Cheloniform Fishes, with the* PRIMARY ORDERS.

Sub-families of the BALISTIDÆ.	*Analogies.*	Orders.
1. *Balistinæ.*	Dorsal fins two, armed with spines.	ACANTHOPTERYGES.
2. *Ostracinæ.*	Dorsal fin generally one; the rays soft.	MALACOPTERYGES.
2. *Cephalinæ.*	Caudal, dorsal, and anal fins united.	APODES.
4. *Diodoninæ.*	Jaws neither bearing true, nor representing false teeth.	PLECTOGNATHES.
5. *Tetraodinæ.*	?	CARTILAGINES.

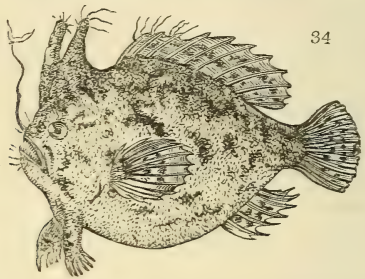
(178.) The analogies of the first, second, and third, are so striking, that nothing need be said by way of further illustration. In respect to the third, we have the means of stating, that, as it represents the apodal order, by the union of its fins, so does it the *Syngnathidæ*, not, indeed, in the form of its body, for nothing can be more dissimilar, but in a part of its structure to which we should hardly have looked for a resemblance, namely, the eye (*fig. 33. a*): this, we can state, on Guilding's authority, is of that particular construction seen in the chameleon reptiles and the syngnathian fishes; it is conical and versatile, so that the fish can look different ways at one time, — a most admirable provision for such animals as are slow and heavy in their motions, like the sun-fish and chameleons; or, by being fixed, (like the pipe-fish) require great quickness of sight and

a wide range of vision. One of the most striking characters of the *Plectognathes* is the deficiency of true scales and teeth; the latter is consequently more apparent in the *Diodonidæ* than in any other, although, in several other respects it is aberrant.

(179.) Again, some very singular coincidences will arise by comparing this family with the primary groups of the quadrupeds and birds, but the analogical relations will, of course, be very remote. The *Diodonidæ*, for instance, are the most aberrant of the whole circle,—a station likewise held by the porcupines, the hedgehogs, and the spined rats, in their own proper circles among quadrupeds: hence we immediately see one of the analogical reasons, so to speak, of *Diodon* having the longest spines of all the cheloniform divisions; for, had it been otherwise, there would, apparently, be wanting some one character by which all these diversified groups would be analogically related. But into these details it is needless to enter, seeing that, if we have not erred in the foregoing table, all other analogies, near or remote, will follow as a matter of course. We leave the presumed analogy of the *Tetraodinæ* and the *Cartilagines* for future determination. When we consider that little or nothing is known of the manners of these fishes, and that, if the peculiar form of the eye in the *Cephalinæ* had not been discovered, nothing would have been left to show their analogy to the *Syngnathidæ*, we need not be sceptical on this point of our comparison: if nothing was left to be discovered, our knowledge of nature would be perfect.

(180.) The second family we consider to be represented by the CHIRONECTIDÆ, or frog-fishes, at present comprised under one genus; yet the species and forms are so few, that its internal relations cannot be made out. The characters of this group are so different from the *Acanthopteryges*, where Cuvier has placed it, that we cannot discover one solitary character they possess in common. The skeleton of *Chironectes*, instead of being osseous, is, as M. Cuvier admits, semi-cartilaginous: the

rays of the fins are all soft: the branchial opening, as in the *Balistidæ*, is confined to a small slit or spiracle: the operculum is concealed beneath the skin, so that the branchia themselves are concealed. Not one of these characters belongs to the typical osseous fishes; while, on the other hand, every one of them are characteristic of the order now before us. Like the aberrant *Balistidæ*, the branchial arches are very few—only four in number; and like them, also, these fishes have the power of inflating their bodies like a balloon when agitated by fear or anger. Their remaining characters, however, are altogether peculiar; and even their very aspect is sufficient to distinguish them (*Chir. histrio, fig.* 34.); they are



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the most grotesque—we had almost said the most hideous—of all fishes, and, as their vernacular name of frog-fish implies, they have nearly as much the appearance of frogs or toads as of fish; this similarity may be perceived in the head of *Malthe nasuta* (*fig.* 35.). The late Mr. Bennet has very justly insisted on the intimate affinity between these strange-looking creatures and the file-fish, or *Balistidæ*,—an affinity which has only been disturbed, as we believe, in the *Règne Animal*. The imagination can scarcely conceive more fanciful forms than such as

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are actually found in this group; and the monstrous combinations which painters have represented under the aspect of animals, can scarcely surpass the singularity of many of these real fish. True it is, that they have their representatives, like the *Balistidæ*, in other groups; but a slight degree of attention, even to their external characters, will prevent them from being confounded with any other; for, as M. Cuvier well observes, indedependently of their semi-cartilaginous skeleton and naked skin, destitute of any scales, the frog-fish have each of the pectorals supported by two bones, analogous to the *radius* and *ulna* of the frogs, although, in reality, they belong to the carpus, and which, in this group, are longer than in any other. The ventrals, again, are placed much before the pectorals, and stand, as it were, upon peduncles; they are thus enabled to perform the office of feet. The effect of this singular organisation is, that these fishes can "creep almost like small quadrupeds; the pectorals, from their position, performing the office of hind feet;" and their nature is so truly amphibious, that they can "live out of the water for two or three days;" they are, in fact, so tenacious of life, that they have been transported alive from the Tropics to Holland, "where they sold as high as twelve ducats apiece." M. Cuvier, with his usual anatomic skill, has determined the characters of many distinct species, confounded under the specific name of *Histrio*,—a name not given, as some have supposed, from any fancied activity of these animals — for they are remarkably heavy and slow — but from the patched and party-coloured spots with which they are variegated.

(181.) We separate from the last group the *Lophidæ*, or fishing frogs, which, although few in number, and evidently connected to the *Chironectidæ*, nevertheless present us with so many peculiar characters, that we look upon them as representations of a *family*, rather than of a *genus*. These reptile-looking fishes have the head enormously large, broad, and depressed; the mouth very wide, armed with pointed teeth, and furnished

with cirri: the branchia are only three, and the spiracle small; in other respects, their skeleton,—the situation of the pectoral and anal fins, the vertical position of the eyes and of the mouth,— all approximate these hideous fishes to the *Chironectidæ*, with which they were placed by Linnæus in his genus *Lophius*. The angler, or fishing frog, of Britain, is a good example: it is said to hide itself among weeds and mud, where, by agitating the long filiform processes on the head, it attracts the small fishes upon which it preys. How far the genus *Batrachus* of authors, as it now stands, forms a part, if any, of this group, it is almost impossible to determine. It seems clear to us, that several distinct types, naturally belonging to groups in the acanthopterygious order, have been placed in this; the essential characters of which are, that the skeleton is semi-cartilaginous, the skin invariably destitute of true scales, and the pectoral and ventral fins pedunculated. M. Agassiz has not failed to remark the affinity of such fish as his *Batrachus punctulatus** to *Cottus*, *Uranoscopus*, and *Trachinus*, with which we believe they are truly connected; but so much obscurity hangs over this group, that we shall restrict it, for the present, to those which are destitute of true scales, however small, and whose ventral fins are, in some measure, pedunculated.

(182.) We place the SYNGNATHIDÆ as the last and most aberrant type of this order, to which it is to be referred on account of its imperfect skeleton, its spiraculated aperture, and the slight development of all those characters which constitute the typical perfection of fishes. Place these singular-looking creatures where we will, they remain, at present, a very detached group; while, if the modification of their branchia, partly composed of little tufts, is of such primary importance, the silurian *Heterobranchi* of Geoffroy Saint-Hilaire have an equal claim to be classed as the representatives of a distinct order. The mode of re-

* Spix and Agass. Brazilian Fishes, pl. 74.

spiration, or the form of the branchia, in all animals, *must* be variable in that part of the series of beings, or those links of her chain, where Nature is about to assume some other form of structure: it consequently follows that, in such cases, the character which heretofore she has assumed, sinks into secondary importance, as *a sole instrument for classification*, where it is about to be quitted and exchanged for another; and if we wish to follow Nature in her own course, we must not merely look to one of her characters, but to all. The insessorial order of birds, for instance, are strictly terrestrial, yet there is one genus among them — the *Cincli*, or water ouzels — which are altogether amphibious. If, therefore, we are to adopt the idea that the *Syngnathidæ*, on account of their branchia, should be considered the representation of a distinct order, the same rule, by parity of reasoning, should be followed in the case of *Cinclus*: all the insessorial birds would thus be divided into two orders, the terrestrial and amphibial; the *Cinclus* alone coming under the latter. Now, as it is by this order that the class of fishes pass into that of the *Amphibia*; so it is not only probable, but almost necessary to the harmony of the series, that the great difference in the repiration of these two classes should be marked by animals presenting a union of both. The branchia of the *Syngnathidæ*, as we conceive, are precisely of this description; and while this one character determines the situation of these fishes in the natural series, we must class them in that order, to which, in all other points, they bear the strongest resemblance of affinity. Indeed, there is no great innovation in this, because M. Cuvier himself places the *Syngnathidæ* close to the *Balistidæ*. The structure and appearance of this family are as remarkable as its economy and habits. From their long slender bodies, they have got the name of pipe-fish: the snout is excessively lengthened, and is terminated by a little mouth, opening almost vertically, and destitute of teeth: the body itself is covered with a cuirass of bony plates, which renders it angular: the

operculum is large, but confined; and the aperture is merely a spiracle: the branchial rays are much the same as in ordinary fishes; but the branchiæ themselves, instead of being fringed or pectinated, form a number of small rounded tufts or fascicles. In what seems the typical division, a most singular conformation prevails, discovered so far back as 1785, by Walcott, a learned naturalist of this country, whose words we shall here quote. "The male (of the *Syngnathus*) differs from the female, in the belly, from the vent to the tail fin, being much broader, and in having, for about two thirds of its length, two soft flaps, which fold together and form a false belly or pouch. They breed in summer, the female casting her roe into the false belly of the male."* Here the eggs are matured; and the young, when ready, escape from the capsules and shift for themselves. Nevertheless, it appears certain that, as in the marsupial quadrupeds, the young again resort to this natural shelter, even after they have quitted it for the first time. Mr. Yarrell says, "I have been assured by fishermen, that if the young were shaken out of the pouch into the water, they did not swim away, but when the parent fish was held in the water in a favourable position, the young would again enter the pouch." Another extraordinary peculiarity of these fish,—at least, of those of the genus *Hippocampus*,—is the prehensile nature of their lengthened and finless tail; they twist this member round the stems of marine plants, and in this position dart upon such small insects or other animals as come within their reach. "The eyes move independently of each other, as in the chameleon: this, with the brilliant changeable iridescence about the head, and its blue bands, forcibly remind the observer of that animal." This analogy is still more perfect, from the fact of the chameleon fixing itself, as it were, by the tail, when looking out for its prey, precisely in the same manner as the *Hippocampus*. Analogies so strong be-

* See Yarrell's British Fishes, vol. ii. p. 328., where the reader will find many other interesting particulars relative to the group.

tween fish, reptiles, and quadrupeds, are too remarkable to be incidental; and it is an extraordinary fact, that, if we place the circles together, which compose these particular groups, we find that, at these points, at least, they stand opposite each other.

Analogies of the SYNGNATHIDÆ.

Circle of the *Plectognathes.*	Circle of the *Reptiles.*	Circle of the *Glires.*	Circle of Class *Pisces.*
Balistidæ.	Saures.	?	Acanthopteryges.
Chironectidæ.	Ophides.	?	Malacopteryges.
Lophidæ.	Elanosaures.	Gliridæ.	Cartilagines.
?	Chelones.	Hystricidæ.	Plectognathes.
Syngnathidæ.	*Chamelides.*	*Marsupidæ.*	*Apodes.*

Our present business is only with the *Syngnathidæ*, which — if the situation here assigned to them among the *Plectognathes* be the true one — is found to represent the chameleons, by its eyes and its prehensile tail; the kangaroos (*Marsupidæ*), by its marsupial pouch; and the apodal fishes, by its want of ventral fins, its eel-like form, and its very long tail, often destitute of a distinct caudal fin. The experienced naturalist will perceive that the series of these columns are not altered to suit our present object, but entirely repose on the analysis of the groups, — these reciprocal analogies having arisen, as it were, incidentally; for they have never, until now, been in the least suspected.

(183.) It will be seen, that in the first column we have expressed a doubt as to the family type which should fill up the hiatus between the *Lophidæ* and the *Syngnathidæ;* and yet there is a most extraordinary fish, of a structure altogether unique, which, if it belongs not to this class, we know not where to arrange; we allude to the genus *Polypterus* of Geoffroy Saint-Hilaire, a freshwater fish of the Nile, and which that distinguished zoologist considers as forming in some degree a connecting link between the osseous and the cartilaginous orders: the opinion of such a profound and experienced observer must always carry with it much greater weight and influence than our own — and the

more so in the present case, because it gives a sanction, in some sort, to the conclusion we have almost come to, that this idea of its relations is founded in nature, and that *Polypterus*, in reality, may ultimately prove the representation of that fifth type of the *Plectognathes*, which we have long been searching after. Limited as is our space, the structure of this fish is so remarkable, that it must not be hastily passed over; the annexed figure of *P. Niloticus* (*fig.* 36.), aided by the following description,

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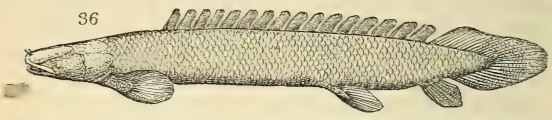

abridged from M. Geoffroy's own account, are therefore placed before the reader. The usual length of the Nilotic *Polypterus* is about eighteen inches, and its colour is sea green, paler beneath, and marked with irregular black spots: it bears some resemblance to certain genera in the *Esox*, or pike family, by the shape of its body, &c.; but these seem to be very distant. The shape is long and anguilliform—the body being nearly cylindrical: the head is defended by large bony plates (*fig.* 37.); and the body

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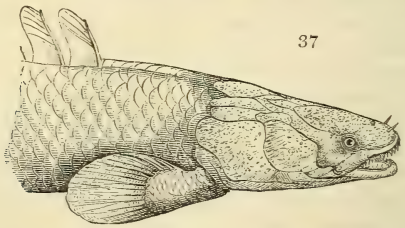

covered, or rather mailed, with large strong scales of a stony hardness, and so firmly attached to the skin that it is hardly possible to open the fish with a knife; so that the natives only draw off the skin whole, after the fish has been boiled. The pectoral and ventral fins, but particularly the former, are attached by a sort of

strong and scaly base or cubit, allowing the same sort of motion as in those of the *Chironectidæ*. The pectoral fins are placed close to the head, and are large, broad at their base, and much rounded; but the ventrals are excessively remote from them, being situated very near the caudal, close to which latter is the anal. The caudal is rounded, and extends further upon the superior than upon the inferior part of the tail, where it is met by a long row of numerous dorsal finlets, which extend along the whole of the back to within a short space of the head: the number of these finlets varies from sixteen to eighteen, each being of an oval shape, and furnished with a very strong spine at its base or origin, while the remaining part consists of four or five soft and branched rays, connected by a membrane: the first, or spiny ray, at about two thirds of its height, sends off a small ascending point or spine. The rays of the caudal fin are soft and articulated, but so disposed in the membrane as to allow of little freedom of motion. The eyes are small and round: the mouth of considerable width; and the jaws furnished with a row of rather small and sharp teeth; while the tip of the upper lip has a pair of small and short cirri: the vent is close to the caudal fin, and at the commencement of the anal. The branchial aperture is large; but in place of a membrane, there is only a single bony plate, or semicircular arch. The stomach is long and large; the liver long, and unequally lobed; the swimming bladder double, and loose; the ovaries long, and the eggs about the size of millet seeds. This highly singular fish is very rare, and is called *Bichir* by the Egyptians. It is generally supposed to inhabit the depths of the Nile; usually remaining in the soft mud, which it is thought to quit only at particular seasons: its flesh is white and savoury. Not having seen this type, we can only form some opinion of its relations by the foregoing description of M. Geoffroy. The only circumstance which makes us hesitate in placing it definitely in this order, is the circumstance of the branchial aperture being large, — a structure altogether unexampled

among all the genera of this order we yet know. The plates of the body, again, although of such excessive hardness, appear, from the figure, to assume the form and imbricate disposition of true scales; and this structure is again at variance with all the other *Plectognathes*. Nevertheless, these deviations in an extreme aberrant type are not altogether insurmountable, under the circumstances of its possessing the pedunculated pectoral and ventral fins of the *Chironectidæ* and the *Lophidæ*, joined with their small and almost vertical eyes—a single ray (if we understand the description) to the branchia—and the uncommon hardness of its covering. It has an obvious relationship to the genera *Lepisosteus* and *Sudis* among the *Salmonidæ;* but whether this is of analogy or affinity we know not. The preponderance of its characters, looking especially at the imperfect development of the branchia, appear to us to be towards those of the *Plectognathes;* but this must be considered and determined by others who have better opportunities of investigating the question. Presuming, however, that *Polypterus* is actually related by affinity to the *Syngnathidæ* and the *Lophidæ*, it will be seen that certain analogical characters would come out, rather tending to strengthen this supposition. As we have not, therefore, tested the order by itself, or by that of the others in the class, we shall do so in the following table:—

Analogies of the PLECTOGNATHES *and the Orders of* FISHES.

Families of PLECTOGNATHES.	*Analogies.*	Orders of FISHES.
Balistidæ.	The most perfectly organised: the types with spinal rays, and with thin membranes to the fins.	ACANTHOPTERYGES.
Chironectidæ.	Fins thick, fleshy; the rays soft and articulated.	MALACOPTERYGES.
Lophidæ.	Body mailed: mouth with cirri.	CARTILAGINES.
Polypteridæ(?).	Branchia slightly developed: pectoral and anal fins pedunculated.	PLECTOGNATHES.
Syngnathidæ.	Tail very long, attenuated.	APODES.

It is needless to enter further into the first two of these analogies, because they must be quite apparent to

the reader: respecting the third, he will remember that the primary character of the *Cartilagines* is not the construction of their skeleton, which applies only to them as fishes, but the great breadth of their head, which extends to all the classes of the vertebrated circle: hence, even if the skeleton of the *Lophidæ* was not semi-cartilaginous, yet the excessive size and width of their muzzle assimilates them at once to the rays and torpedos, which are the cartilaginous types. The vertical outlines, in short, of the torpedo and the fishing-frog, are almost so alike, that, if the details were not filled up, one could hardly be distinguished from the other. We have already stated the characters by which *Polypterus* may be placed among the cheloniform fishes; and the analogy of the *Syngnathidæ* to the apodal order has also been touched upon.

(184.) Our chief attention, however, must be directed to *Polypterus;* and, with the hopes of arriving at more definite ideas regarding its true affinities, we shall compare the presumed contents of the order *Plectognathes* with those of the cartilaginous order, thus: —

Analogies of the PLECTOGNATHES *and the* CARTILAGINES.

Family of PLECTOGNATHES.	*Analogies.*	Families of CARTILAGINES.
Balistidæ.	The types generally furnished with spined rays on their dorsals.	SQUALIDÆ.
Chironectidæ.	The fins always fleshy, and with soft rays.	RAIDÆ.
Lophidæ.	Head or muzzle excessively broad.	POLYODONIDÆ.
Polypteridæ(?).	Banchial aperture very open; body mailed; mouth cirrated; gill membrane one-rayed, or none.	STURIONIDÆ.
Syngnathidæ.	Tail long, attenuated; caudal fin obsolete, or none; mouth very small.	CHIMÆRIDÆ.

Passing over the three first, we must confess that our belief in the alliance of the *Polypterus* with the *Plectognathes* is considerably strengthened, when we now bring it into comparison with the sturgeons (*Sturionidæ*), — a test we had not applied to it when writing the former paragraphs, because we wish this arrangement to repose, not upon the analogies, but on the affinities, of the groups. These two types are the only

ones in their respective circles which have the branchial aperture unusually large; both have the body much lengthened; both have the gill membrane either without any rays, or with merely a single pair; in both, the caudal fin surrounds the extremity of the spine, and (what is very remarkable), in both these types, the upper portion of the caudal is longer than the lower. *Polypterus* is not more unlike the other cheloniform fishes, than *Acipenser* is unlike the rays and the sharks; and yet the latter affinity has been universally acknowledged. Unfortunately, however, we cannot make out whether M. Geoffroy's original memoir on *Polypterus*, which we have not the means of consulting, mentions any thing of the nature of the skeleton: if this is truly sub-cartilaginous, the question, we think, would be at once decided; but if it is osseous, the probability is diminished of this perplexing type entering into the present order. There is, indeed, an evident — though, we think, a distant — resemblance between the form of *Polypterus* and some of the *Siluridæ*, — a resemblance which results from the one, apparently, representing the other, as will be seen in the following comparison: —

Families of the PLECTOGNATHES.	Families of the MALACOPTERYGES.
Balistidæ.	*Pleuronectidæ.*
Chironectidæ.	*Salmonidæ.*
Lophidæ.	*Cobitidæ.*
Polypteridæ (?).	*Siluridæ.*
Syngnathidæ.	*Gadidæ.*

But it is not necessary to prolong this discussion; and we shall, therefore, at once proceed to the next order.

CHAP. VIII.

ON THE APODES, OR ANGUILLIFORM FISHES.

(185.) THE fishes belonging to the Linnæan order of APODES, — a name which we shall now revive, — are not

more numerous than those of the last, yet they are equally well marked; nor can they be blended into any other of the classes without a disregard to those natural relations which, as we have already seen, constitute them a primary division. Their slender, cylindrical, and serpent-like body, as seen in the eels (*Ang. acutirostris* Yarr., *fig.* 38.) generally destitute of scales, and

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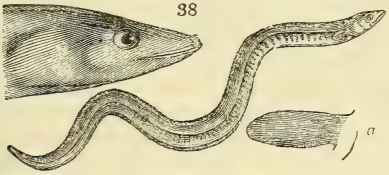

covered with slime, separates them, at first sight, from the *Plectognathes*, or cheloniform fishes; absence of ventral fins detaches them equally from the order *Malacopteryges;* while the softness of their fins, the rays of which are never spinous, no less separates them from the *Acanthopteryges.* Finally, from both these latter orders they are further distinguished by having the operculum and branchia concealed; the former being covered with the common skin of the head, which only leaves a small slit or spiracle (*a*), by which they breathe. This latter is a universal character; and is the more to be valued, since, whatever eel-shaped or anguilliform fishes are found scattered in other types, even though they may have soft fins, or only the rudiments of ventrals, yet they never have these two characters united with the spiraculated aperture.

(186.) The Apodes, as we have already shown, occupy that part in the series of fishes which mark the transition from the cartilaginous to the osseous. Hence no definite character for them is to be derived from the nature of their skeleton, except this, indeed, —that a gradual progression in its development may be traced in the different families, from the semi-carti-

laginous structure of *Lophius*, to the bony skeleton of most of the eels; and, at the same time, a falling off to the faintest indication of the vertebral column, as in *Myxene glutinosa* (*fig. 39.*), which all authors agree in

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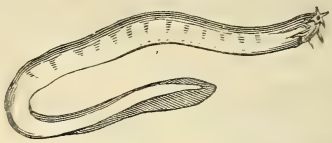

placing near to the worms. The order, however, stands in no need of any additional characters than those we have pointed out. The common eel may be cited as the most perfectly typical of the whole; while the eel-shaped lampreys, as all writers agree, indicate the manner in which the class of fishes blends into that of the annulose animals, or insects. It may further be remarked that this, no less than the other two aberrant orders of fishes, affords us no example of true deci uous scales. Nevertheless, as the *Apodes* blend into an order where this sort of covering is almost universal, we now begin to see their incipient commencement. Many of the eels, for instance, have very small scales, but so covered over by their thick and fat skin, that they are scarcely visible when the animal is alive. True scales, on the contrary, are always placed upon the *surface* of the skin, and, as every one knows, may be easily detached, or even rubbed off. Linnæus, indeed. placed all fishes not having ventral fins within the limits of this order, and hence rendered it a most artificial assemblage. M. Cuvier, who still preserves the major part as a distinct and "natural family," has much improved on this arrangement; although he has still left in the group several genera, which, to our views, are evidently separated from their true congeners. *Ophidium* and *Fierasfer*, from having unattached opercula, and wide branchial apertures, we arrange with the *Gadidæ*: *Ammodytes*, in like manner we refer to the *Gymetres*, or riband-fish, with

which, also, we suspect some of *Gymnarchi* are naturally allied.

(187.) Our general sketch of this order must be very brief; for, as we have not space for a lengthened exposition of every family, we shall only dwell upon those which more especially seem to require elucidation; and the popular history of the eels, and other well-known fishes belonging to this group, however interesting, is not exactly suited to the nature of these volumes. We shall therefore at once proceed to the natural families of which the order appears to be composed, referring the reader to the general synopsis for the characters of the minor divisions.

(188.) The eels appear to arrange themselves into two divisions: the one, which we designate the *Muræniдæ*, having two branchial spiracles in their ordinary position; and the *Sphagebranchidæ*, or sea eels, where the branchial spiracles are either close together or united into one, and in both cases are placed under the throat. These we denominate the typical groups. The three aberrant depart more or less from this structure, and each assumes some of the characters of that particular order to which it leads: thus, the *Gymnarchidæ* have the head and body compressed, as in ordinary fishes, and the scales are more developed than in the other divisions; because this group, as it appears, leads to the acanthopterygious order. The *Petromyzonidæ*, or lampreys, have the skeleton almost obsolete; the body worm-shaped, and without scales: some of these lead to the *Vermes*, and others to the cartilaginous order. Lastly, we have the *Cyclopteridæ*, or suckers, characterised by their ventral ring; thus connecting the *Gymnarchidæ* to the *Plectognathes*, by means of the lump-fish and the *Lophidæ*, or frog-fish. A few general remarks upon these groups seem to be necessary, because, however nearly we think they are related, they have never before been assembled together.

(189.) It will be observed, in our last chapter, that the *Lophidæ* are placed at one extremity of the

cheloniform order, and at that particular part which forms a passage to the *Apodes*. Now this passage, as we conceive, is effected by that singular-looking fish — scarcely less grotesque than the *Lophius* — familiarly called the lump (*Cyclopterus lumpus**): both these have their skeleton more or less cartilaginous, particularly the latter, which, by the intervention of *Liparis*, becomes intimately connected with *Lepidogaster* and the genus *Gobiesox*. The passage from these to the eel-shaped genera, is obviously effected by Cuvier's genus *Alabes:* from this we have an uninterrupted series of forms through the two typical families of the *Muræ-nidæ* and the *Synbranchidæ:* these latter, again, are closely connected to the *Sternarchidæ;* and thus we are led to the last and most imperfect of all fishes, namely, the *Petromyzonidæ:* between some of these latter and *Liparis*, as well as with our new genus *Rupisuga*, there is an obvious affinity; and thus, having returned once more to the *Cyclopteridæ*, the outlines of the circle become sufficiently marked to make us believe that the whole form a natural group.

(190.) Nevertheless, from not having finished, at present, the analysis of this order in its more minute details, we feel some lurking doubts as to the precise situation of the family *Petromyzonidæ*, or, rather, of some of its genera. The analogies, however, of the other groups to those of the orders, appear sufficiently strong to lay before the reader: they may be stated as follows: —

Analogies of the APODAL *Order.*

Families of the APODES.	*Analogies.*	Orders of FISHES.
1. *Murænidæ.*	Skeleton osseous: the most highly organised.	ACANTHOPTERYGES.
2. *Gymnarchidæ.*	Sub-typical.	MALACOPTERYGES.
3. *Cyclopteridæ.*	Head broad; the snout depressed and obtuse.	CARTILAGINES.
4. *Petromyzonidæ.*	Eyes minute; mouth small, circular.	PLECTOGNATHES.
5. *Sternarchidæ.*	Tail excessively long.	APODES.

* See the figure, and an interesting description of its habits, in Mr. Yarrell's Brit. Fishes.

It is somewhat singular that the first, third, and fifth of these analogies are more clear than the intervening ones: and yet this very circumstance, instead of weakening, rather tends to strengthen, the probability of the whole being correct; for it cannot be doubted that M. Cuvier is perfectly right in placing *Gymnarchus* immediately after *Muræna:* and as all writers, ancient and modern, agree in the opinion that the lampreys and the *Myxene*, of all fishes, are those most allied to worms, so they become the most aberrant of the order. Again, the skeleton of *Myxene* is so slight, that it is not even cartilaginous; while that of *Liparis*, among the *Cyclopteridæ*, is equally imperfect, being almost gelatinous. It may be further remembered, that very small eyes is one of the characteristics of the cheloniform type; witness the whole of the *Balistidæ* and the *Chironectidæ*, numerous genera of the *Siluridæ*, &c.: now this limited vision is carried to its highest *im*perfection in the lampreys; for some of the genera are actually blind, having no eyes whatever. Finally, of all the apodal order, length of tail, which is one of its primary characteristics, is especially developed in *Sternarchus*, so named, because, although it is a long fish, the *anus* is close to the *sternum*. Nevertheless, we wish it to be remembered on this, and on all other occasions, that analogies (however necessary to the confirmation of an arrangement supposed to be natural) are of inferior importance to affinities.

(191.) In regard to the situation of *Petromyzon*, which we have removed from the *Cartilagines*, it is quite clear that no one would have arranged it in the same order with sharks and rays, but for the similarity of its branchia. Now, if this part of its structure is really of such importance as to decide its place in nature, it may be fairly asked, Why is not this absolute rule acted up to in the case of *Myxene*, whose branchial apertures are like those of the eels? These two genera cannot be separated: and is not *Myxene* infinitely more allied, in all parts of its structure, to *Gymnarchus*, than *Petromy-*

zon is to the sharks? No one will dispute this. What, therefore, is the logical deduction, but that the *Petromyzonidæ* should be naturally arranged with those fishes with which, in their general organisation, they have the nearest resemblance? The structure of the branchial apertures, indeed, in this group, are so variable, that they absolutely become hardly sufficient to characterise a genus; much less to determine an order. Among the *Gymnarchidæ*, or sea eels, for instance, they are close together and under the throat in *Sphagebranchus;* united almost into one in *Monopterus;* single, and round, in *Synbranchus;* before the pectorals in *Gymnotus*, and behind them in *Muræna:* in short, they almost assume every possible form and situation within the limits of a few genera,—a clear proof how completely secondary these characters become in the present group. It would seem, indeed, that Nature, upon leaving the annulose circle, and entering that of the fish, intended to show us all the forms of variation in the first group, which she afterwards employs to characterise higher divisions: this she has done in the class *Acrita*, as Mr. MacLeay has so beautifully illustrated*; and the same remarks may be made applicable to the group before us: the least organised of all the fishes, as the *Acrita* are the least among animals.

(192.) But there is another inference to be drawn from the peculiar structure of the lamprey, sufficiently important to merit a separate notice. In a former volume, we have stated the proposition that one of the primary laws of the circular succession of all groups is, that the three aberrant divisions constitute a circle of their own, independent of their connection to the other two; from which it follows, that the primary circles in every group (when that group is perfect in all its parts) are *three*, although they appear to be *five*. We have shown that this is more than probable in the union of the monocardian animals; and even Cuvier confesses the affinity of certain of the cartilaginous order to rep-

* Hor. Entom. See also Classif. of Animals.

tiles: and when we consider that some of the foreign eels have actually no fins whatever, the only essential difference that remains between them and serpents is their diverse modes of respiration. This theory, again, receives strong support, if not direct confirmation, by the structure of the branchia in *Petromyzon*, which is precisely that of the cartilaginous fishes; it thus effects the union of that order with the *Apodes*, so that the three aberrant divisions of the whole class become united into one circle: there is, in short, no other mode of accounting for this singular departure of *Petromyzon* from *Myxene* and *Gastrobranchus*,—two genera with which, in all other respects, it is so naturally and confessedly allied. Viewed in this light, the apparent anomaly becomes absolute harmony; since, were the branchia of the lampreys like those of the *Myxene*, no passage whatever could be traced between the *Apodes* and the *Cartilagines*.

(193.) Without entering, in this place, into scientific details, or lengthened popular descriptions, we may yet make a few general observations on the different families under which, for the first time, we have distributed the genera. The typical families, *Muræ-nidæ* and *Synbranchidæ*, comprise all the true eel-shaped fishes, having serpent-like bodies, long and cylindrical: they are either naked, or with scales so minute as to be barely perceptible. In the first, the branchial spiracle, or opening, is situated as in the generality of fishes, that is, on the sides of the neck, close to the pectoral fin (*fig.* 38. *a*); but, in the latter family, they are always placed on the under part of the throat, and thus are close together. Their general aspect is so like that of reptiles, that they may be termed serpent-eels, in contradistinction to the former, or true eels. The habits of the *Murænidæ*, in general, are pretty much the same as those of the common eel and the conger. Some few are confined to fresh waters, but the majority live near the mouths of rivers. The eels, properly so called, have pectoral fins; but in the *Muræna*, or sea eels, no pectorals exist, as in *Gymnothorax Zebra*

(*fig.* 40.). From the peculiar structure of their gills,

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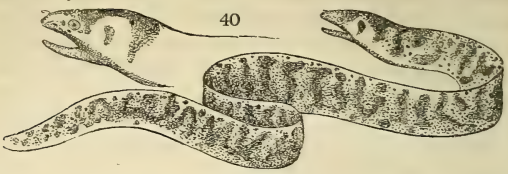

the eel is capable of living out of the water a considerable time—some say many days; and when the waters of one of their haunts are dried up, they are well known to have the power of making their way by land, during the night, to other localities where water exists. They feed on almost any thing—subsisting both upon living and dead animals, and also on aquatic plants. The genus *Alabes* is particularly remarkable from having a small concave disk between their pectoral fins; so that the connection between the eels and the suckers (*Cyclopteridæ*) is rendered complete.

(194.) The circle of the *Muræniдæ* contains by far the greater number of the apodal fishes; and presents us, under the general form of the eel, with a great diversity of modifications. In the most perfect or typical division, the sub-family *Anguillinæ*, or true eels, the pectoral fins are always present, as in the conger (*fig.*41.):

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the head is depressed, the muzzle rather obtuse, and the teeth small: the branchial spiracle is in the form of a slit (*a*), placed just before the base of the pectoral fin, but rather below it; and the nostrils are always tubular; the dorsal, caudal, and anal fins are united into one: but in the new genus *Ariosoma* Sw. the nostrils are not tubular, and the branchial aperture is in front of the

pectoral. Several of these fishes inhabit the Sicilian shores; and they are richly coloured with silver reflections, very different from the lurid hues of the true eels. Another extraordinary form is seen in our *Leptognathus oxyrhynchus* (*fig.* 42.), which immediately reminds us

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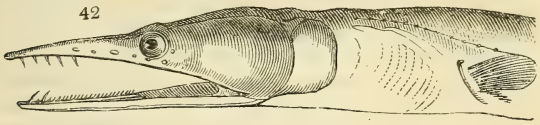
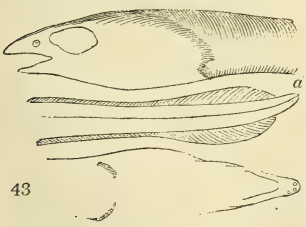


of *Laurida*, *Sphyræna*, and all such analogous types; it has the pectoral fins of *Anguilla*, but with the naked tail of *Ophisurus* Lacep.: this, also, seems one of the rare Sicilian fishes unknown to modern writers. Several others will be found designated by professor Rafinesque. The next sub-family of *Muræninæ* contains those eels which are altogether destitute of a pectoral fin; but the two branchial spiracles are placed, one on each side, in the same situation as the last. The name of this division is taken from those species which were so highly esteemed by the Romans; and therefore M. Cuvier has very properly rejected those of more recent nomenclators. * Among these there are even more variations than in the *Anguillinæ*, not merely in the structure of the teeth, but in the form and relative proportion of their fins. The most typical have the dorsal and anal united: but in the singular genus *Dalophis* Raf. (*fig.* 43.), with which M. Cuvier says he is not acquainted, the end of the tail is completely naked (*a*), as in our *Leptognathus*; while in *Nettastoma* Raf., which was likewise un-



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* *Gymnothorax* Bloch; *Muræenopsis* Lac.; *Anguilla* Raf.

known to him, the branchial apertures are even more beneath the neck than in *Dalophis*, although the fins are like those of *Muræna*. These instances, taken almost at random, will be sufficient to show how very little is yet known of the European genera and sub-genera of this order, and may stimulate foreign ichthyologists to explore more distant seas, where numerous others will, no doubt, be discovered.

(195.) The *Synbranchidæ*, or serpent eels, are all marine, and numerous species are scattered in all the temperate and tropical latitudes: excepting the *Petromyzonidæ:* they are the least organised, as fish, of any in the order, for some of the fins, exclusive of the ventral, are often wanting; and in *Cœcilia* Lac. all these organs of motion totally disappear. The species contained in this division, hitherto determined, are few; but we believe very many have been overlooked, more especially in the *Règne Animal*, where we find no notice taken of those discovered on the Sicilian coast by professor Rafinesque, who has characterised several excellent sub-genera, to be found in our synopsis.

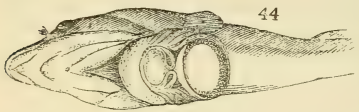
(196.) The *Sternarchidæ* are so named from the body being so excessively short that the vent is close to the sternum. Nevertheless they are very long eel-shaped fishes, although the body is more or less compressed; sometimes (as in *Carapus*) covered with visible scales, and having altogether something of the appearance of ordinary fishes. In all these the spiracles are lateral, and they all exhibit a tendency to blend into the acanthopterygious, or spine-rayed order. The famous *Gymnotus electricus*, or electric eel of South America, seems to belong to this division, which (if its analogies are examined) will be found to represent the torpedos in the circle of the *Raidæ*, and the electric silures in that of the *Siluridæ*. All the species hitherto known — and they are but very few — occur out of the European range, except, indeed, that curious genus *Leptocephalus*, which clearly represents, in this family, that of *Amphioxus* in the next.

(197.) The *Petromyzonidæ*, or lampreys, for the reasons already assigned, we have placed as the most aberrant family in the order. Their very low state of organisation renders them the most imperfect of all vertebrated animals, or, at least, of the whole class of fishes. Their skeleton is so soft as not even to be cartilaginous: the vertebræ are indistinct, and are perforated by a central tendinous cord, filled with a mucilaginous substance; the vertebral column thus becomes a series of rings, and is hardly more solid than the mucilage within. The gills, instead of being pectinated, as Cuvier remarks, more resemble pouches, resulting from the union of one of the faces of one gill with the opposite face of the neighbouring gill. In some there are seven branchial spiracles on each side, but in others only one. Their external form, however, is quite sufficient to make them immediately known. The body is eel-shaped, devoid of ventral and pectoral fins, or, indeed, of any true fin; for that elongation of the skin which forms the dorsal and unites to the ventral is devoid of any rays: the mouth is circular, placed on the lower part of the head, and forms a maxillary ring. Such as have the mouth armed with rows of strong teeth and tubercles, like the true lampreys, are able, by this apparatus, to adhere to stones and other substances with astonishing tenacity; by the same means they are said to attack the largest fishes, which they pierce and devour by their rasp-like teeth. Of this very remarkable family, three principal types, or genera, are only known: the first is *Petromyzon*, or the true lampreys, having several lateral spiracles; the second is *Myxene* *, where the spiracles are only two; the third is represented by the *Amphioxus* of Mr. Yarrell: the whole may be characterised by having the skeleton almost mucilaginous; the

* Subsequently named *Gastrobranchus* by Bloch, who has admirably illustrated its internal structure. This group, as seen in the *Règne Animal*, is another instance of the Linnæan genus *Myxene* being nominally retained, but virtually abolished: Cuvier divides *Myxene* into three genera, but does not retain the original name to any one. The nomenclature and the arrangement appear to us equally objectionable.

mouth placed beneath, presenting, when closed, the appearance of a fissure placed longitudinally, and not, as in all other fishes, transversely with the body: the eyes are very small: the rays of the fins are obsolete, or nearly wanting; and there are no ventrals or pectorals. Between *Petromyzon* on one side of *Amphioxus*, and *Myxene* on the other, there are still wanting two types to complete the circle of this family: one of these types would also fill up the only link wanting between *Amphioxus* and *Leptocephalus;* while the other would connect *Amphioxus* with *Liparis* and the lump-suckers.

(198.) The *Cyclopteridæ*, or lump-suckers, form the concluding family of this order. Like the last, their skeleton is so soft, that some of these fishes are said to dissolve after death into nothing but jelly, or mucilage: like the lampreys, also, they are adherent, or suckers; but this faculty, instead of lying in their mouth, is transferred to the pectoral and ventral fins, both of which, by being united into a circular disk (*fig.* 44.),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form two powerful suckers, by which these animals adhere to rocks, stones, or other substances, and even to the hand of those who capture them. They are smooth, destitute of scales, and of an ugly appearance. Sometimes the disk, as in the genera *Liparis* and *Cyclopterus*, is only single; but in *Lepadogaster** and *Rupisuga*, it is double. Like all the fissirostral types, or their representatives, the head of these fishes is uncommonly large and greatly depressed, although the body is *com*pressed: the snout is rather lengthened and obtuse; so that, in short, we are presented with such a miniature resem-

* The genus *Piecephalus* of Rafinesque appears to differ from this, in having the ventral or abdominal fins forming a semicircular plate, whose concavity is turned towards the head, and furnished with scattered cup-shaped suckers (*sparse di cupule succhianti*); there is no operculum, but a three-rayed membrane; and the tail is heart-shaped, or emarginate. — *Raf. Caratt.* p. 69.

blance to that of the generality of sharks, that the outline of the head of one would almost serve for that of

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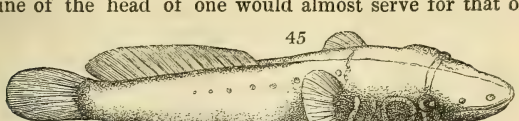


the other. A new species from Sicily, — the specimen of which, sent to the British Museum, but now lost, — is here figured from our original drawing (*fig.* 45.).

(199.) The union of the sucking fish with the eels, as before observed, is effected by Cuvier's genus *Alabis*, and Rafinesque's *Piescephalus*. This latter is placed by Rafinesque with the eels, with the observation, that it has several characters of conformation with *Lepadogaster;* and there is good reason for the remark, for both have the power of adhering, by means of concave disks on the throat. Although we have never seen this extraordinary fish, we feel perfectly sure that future investigations in the Mediterranean will bring it again to light. But whether we take this for the connecting link, or Cuvier's genus *Alabis*, we find the suckers brought into immediate union with the eels, — thus uniting all the apodal families into one complete circle; and so perfectly is this effected, that we may at once dismiss the subject, and pass onward to the next order.

CHAP. IX.

GENERAL ACCOUNT OF THE MALACOPTERYGES, OR SOFT-FINNED ORDER; AND OF THE ANALOGIES OF THE FAMILIES.

(200.) The great order of fishes characterised by Artedi as the *Malacopteryges*, is composed, as already observed, of those whose fins are supported by soft or

articulated rays. The branchial opening is always wide*, with the gills perfect; and although in some there are no teeth, the jaws are never prolonged into sharp plates, as in the chelonian fishes. This is the chief typical character, and the exceptions are very few. In some, as in the *Siluridæ*, the first rays of the dorsal and pectoral fins are represented by bony spines, the sides of which are crenated, or toothed, like a saw. In the flat fish (*Pleuronectidæ*) the rays are semi-spinous; and even among the most typical families, the first two or three dorsal rays are rigid: yet all these deviations take not from the fact, that the whole of these fishes are known by the absence of spiny rays, *placed after the first or second* in any of their fins. Thus characterised, we may at once take a general view of the primary divisions under which we shall now arrange them.

(201.) The soft-rayed fishes, although composing a circle of equal rank to that of the spinous rayed, are yet so inferior in point of extent, that they do not, in all probability, amount to more than one fourth of the number comprised in the great typical circle of the *Acanthopteryges*, or spine-rayed fishes: they are inferior to them, also, in the elegance of their shapes and colours; but, on the whole, are superior in point of utility to man, since they comprise by far the largest proportion of such as furnish him with food. When we enumerate the salmon, cod, turbot, herring, and carp tribes, as belonging to this order, we absolutely name nearly all those which not only supply food to the great bulk of mankind, but in whose capture thousands of men and fleets of vessels are exclusively engaged: the greatest part of these are, of course, marine; but it is also a natural character of this order, that it likewise contains nearly the whole of those families which live exclusively in fresh water.

(202.) The primary divisions appear to be as follows: the first, and most typical, are the *Salmonidæ*,

* Except in that group which leads to the cartilaginous order.

or salmons; while the second, or sub-typical, seem to be the *Pleuronectidæ*, or flat fish; then follow the three aberrant groups, represented by the *Gadidæ*, or cods, the *Siluridæ*, or cat-fish, and the *Cobitidæ*, or loaches. That all these groups are united into one great circle, is evident: for although, in tracing the series, we shall find an *hiatus*, which nothing yet known can fill up, there is yet such circumstantial evidence proving the series of those forms which we already know to be natural, that we can only look upon the inequality of the links as arising from one or other of those causes elsewhere explained. We here allude to the interval between the *Salmonidæ* and the *Pleuronectidæ*, or flat fish. All ichthyologists agree in considering these latter to be the most isolated group among fishes, just as the *Psittacidæ*, or parrots, are among birds; and for the same cause, namely, that there are no forms among them so aberrant as to mark beyond doubt the character of the group by which they are preceded, and that, again, by which they are followed. In deciding, therefore, the probable station which such an apparently isolated group would hold, we must have recourse to inductive reasoning. First, then, there can be no doubt on the acknowledged fact, that the *Pleuronectidæ* belong to this order, not merely because all writers have so placed them, but because they would interrupt the series of the other circles; and, further, because they have some affinity to the *Gadidæ*, near to which M. Cuvier, following all his predecessors, has placed them; both having the anatomical character of the ventral fins being attached to the pectorals, and the pelvis immediately suspended to the bones of the shoulder. This affinity, therefore, being established, we have only to follow the thread of progression from *Gadus* to the next and to the next family, until, having gone as far as we can, and successively established our groups as we proceeded, there is no other conclusion to be made than this, — that where the line of affinity becomes lost, is precisely where those forms which should lead us back again from our starting post is wanting. Now, this is a precisely ana-

logous case to that of the *Psittacidæ* among the scansorial birds, where we have the series as much interrupted on one side, but not quite so imperfect on the other; and yet no ornithologist would think of placing the parrots in any other situation than between the woodpeckers and the toucans. But let us look to this question in another point of view. Let us suppose that all the aberrant types* of the rays (*Raidæ*) were unknown or destroyed, and that the only representations of them now in existence were the skates or rays: looking, then, to these only, and to the sharks, how slight—how questionable—would be their affinity! One would imagine that, if they were really related, whole families of intermediate forms would be necessary to connect them; and yet how completely has nature effected this by such forms as *Rhinobates* and *Pristis*,—two little groups which blend the form of the rays and the sharks so completely, that ichthyologists are even undetermined where one ends and the other begins. And so, may we fairly presume, is the case with the *Pleuronectidæ* and the *Salmonidæ*. It will be subsequently explained on what grounds we believe these two are the typical groups of the present order; and two or three genera would be quite sufficient to unite them as perfectly as are the *Raidæ* and the *Squalidæ*.

(203.) With the above exception, therefore, we shall find the circle of the malacopterygious fishes sufficiently perfect. From the *Salmonidæ* and the *Pleuronectidæ* we pass on to the *Gadidæ*. This latter affinity has long been admitted; and the connection, not at all remote, is further established by the holibut,—a well known and gigantic flat fish, beginning to assume the thick and lengthened body of the cod and haddock. We quit the *Gadidæ* by means of *Brotula* and *Oligopus*, — genera which blend their own group in the most perfect manner with that of the *Siluridæ*. It is here that we have the most aberrant forms of the order: the first rays of the

* *Torpedo*, *Squatina*, and *Rhinobates*.

dorsals and pectorals are not only spines, but become bony, lance-headed plates; and the other rays are generally so thick and strong as to possess little flexibility. From these the passage to the loaches is remarkably gradual; and as we now arrive at that part of the circle which touches the cartilaginous order, we accordingly find that these fishes show a decided relation to that group by their viviparous nature. All writers place the loaches in immediate conjunction with the *Cyprinæ*, or carps, which belong to the *Salmonidæ:* and as these latter form a circular group of themselves, we return from whence we began; and thus we find all the divisions, on one side of the *Pleuronectidæ*, sufficiently well united, although capable of containing other and more intimate links of connection. Before proceeding further, we shall briefly notice the distinguishing characters of the families whose affinities we have just endeavoured to trace, and then see how far their analogies are conformable to the theory of representation.

(204.) The *Salmonidæ* not only include the salmons, but nearly all the freshwater fish of Europe, and a great proportion of those peculiar to the lakes and rivers of other countries. They are distinguished, as a whole, by having all the rays of their fins soft; or, if any exceptions exist to this character, it is merely found in some of the perches, where the first and second dorsal ray is simple and rigid. They have the body protected by large and well-formed scales, by which they are distinguished from the cat-fish (*Siluridæ*), and have not that fleshy covering to the fins so general among the *Gadidæ:* they differ from the loaches in their being oviparous, and in certain other anatomical characters hereafter to be noticed. This we look upon as the most typical division of the whole order; and it preserves this character in being most numerous in species, and most diversified in its forms. It contains the different groups known under the familiar names of carps, trouts, salmons, pikes, and herrings.

(205.) The second, or sub-typical group, are the *Pleuronectidæ*, or flat fish. These are at once recognised by their remarkably flattened bodies, of an oblong or rhomboid shape: the circumference is almost completely margined by the dorsal and anal fins, the rays of which are, for the most part, spinous: the eyes are placed on the same side of the body; and this side, which is the upper surface, is coloured so as to resemble the ground upon which these fishes lie in wait, among mud, sand, and weeds, to seize their prey: the under surface, from never being exposed to the action of the light, is always colourless, and generally of a fleshy white: the scales are small and well-defined: and the whole of the species are marine. They are, however, very few in number when compared with the *Salmonidæ*, and present but few variations in their general structure.

(206.) The *Gadidæ*, or cod-fish, also form but a small family, although with several well-defined variations of structure. They have the usual shape of ordinary fishes, and are entirely marine. The small scales of the body are covered, and often nearly concealed, by a mucous skin, which also extends over the fins, and gives them a thickened and fleshy character, not found in the *Salmonidæ*. The head and body is generally but slightly compressed, the eyes large, and the mouth very wide. The ventral fin in this group, is very small, and generally terminates in a pointed fleshy filament, more or less lengthened; and three out of the five rays usually found in this fin are sometimes wanting: this character, hitherto overlooked, we shall subsequently find to be of much importance. The *Gadidæ* present considerable variation in the apparent number of their dorsal fins; in some there are three, in others two, and in a few only one; but the interval of their divisions are so small, that, perhaps, it would be more correct to consider them as having one long dorsal, variously cleft: the snout is often furnished with small *cirri*, or round worm-shaped filaments.

The cod, haddock, and whiting, are familiar examples; and nearly all are confined to the seas of cold or temperate latitudes.

(207.) The *Siluridæ*, or cat-fish, in many respects, have a strong resemblance to some of the last: like them, they are furnished with cirri on the head, but often prolonged to an enormous length: the body is generally soft and mucous, but the head is hard and bony; and although there are no true scales, the head of very many, and the whole body of the typical species, are covered with hard bony plates, which either serve the office of a helmet or a complete coat of mail. The species are very numerous in the great rivers of hot climates, more especially in those of India; and they swarm in the Ganges: one only has been found in the European range; so that we may look on it as a tropical family. The head is greatly depressed, so as to exhibit, when viewed in front, some slight resemblance to that of a cat, from whence the vernacular name of cat-fish.

(208.) The *Cobitidæ*, or loaches, form a small family of freshwater fish, well distinguished from the *Siluridæ* by their elongated and somewhat rounded body, the compression of the head, and the possession, in general, of true scales: they differ from all the other soft-finned fishes, by being viviparous. The primary type, however, of this family, appears to be *Anableps:* their mouth is small, and furnished with cirri; and the aperture of their gills, like that of the eels, is merely a lateral slit behind the pectoral fin, confined by a skin at both extremities: the generative organs of the male have a close analogy to certain of the cartilaginous fishes. The passage from this family to that with which we began, is effected by certain genera, as *Pœcilia, Lebias,* &c., which have the above characters united with the oval body of the carp (*Cyprinæ*); and, indeed, these two families are so connected by their aberrant types, that all writers have arranged them close together.

(209.) Let us now arrange this series, in the first place, in juxtaposition with that of the orders of the whole class, and we shall then find that all the particulars we have stated have a double reference,—one to their actual characters, and another to their analogical relations.

Analogies of the MALACOPTERYGES *and the Orders of* FISHES.

Families of the MALACOPTERYGES.	*Analogies.*	Orders of FISHES.
Salmonidæ.	Rays of the fins soft.	MALACOPTERYGES.
Pleuronectidæ.	Rays of the fins rigid.	ACANTHOPTERYGES.
Gadidæ.	Ventral fins small or none; scales imbedded in the skin.	APODES.
Siluridæ.	Body mailed.	PLECTOGNATHES.
Cobitidæ.	Viviparous; mouth beneath the muzzle, which is broad and depressed; pectoral fins very large.	CARTILAGINES.

We have already shown that the *Salmonidæ* are those fish which have the fin-rays soft; and as they are the most highly organised of the *Malacopteryges*, they consequently represent the perfection of their own order. The *Pleuronectidæ*, in a manner no less singular than beautiful, thus turn out to be prototypes of the *Acanthopteryges*; for Cuvier follows his predecessors in placing them in this order, to which, notwithstanding their spined rays, they undoubtedly belong. The relation of the *Gadidæ* to the apodal or anguilliform order, when attentively considered, will be found no less undeniable. The *Apodes*, besides their eel or serpent formed body, are mainly distinguished by the total absence of the ventral fins: their body is slimy: the scales, which are very small, appear to be imbedded in the flesh, or covered by a fat skin, which extends also over the fins. Now, the *Gadidæ* have as many of these characters as it is possible for fishes to have, whose situation is in this order: of all the *Malacopteryges*, they have the most imperfect anal fins. In the forked hakes, or *Phycis*, it is reduced to

a single ray; and even in the more typical forms, as *Gadus* and *Mustelus*, the three hinder rays are often so short as to appear obsolete: their slimy body, fleshy fins, and minute scales, are all so many characters possessed by the eels; while this resemblance is carried so far in the rocklings (*Motella*), that the forms of both are nearly alike; both having the body very long, and the anal, dorsal, and caudal fins nearly, if not quite, united. The *Siluridæ* are no less strikingly analogous to the *Plectognathes*, or cheloniform fishes. In both there are no true scales, but in both are the typical groups incased in a coat of mailed plates; so that *Loricaria* is as perfect a prototype of *Ostracion*, as the half-mailed *Pimelodes* are of *Balistes*. Finally, we come to those soft-rayed fish, whose mode of generation separates them from all the others of their own order, and likens them to the cartilaginous or *chondropterygious* fishes: these are the *Cobitidæ*, or loaches — one of the most remarkable groups of fish in the whole order. Whether we consider the peculiarity of their external or internal anatomy, we can only feel astonishment that neither one nor the other should have given them a more prominent station in our modern systems than they have hitherto held. To place viviparous and oviparous fish merely as genera following each other, appears just as natural and consistent as if we arranged the flat fish and the skates as cognate families, merely because both are flat, and have the fins surrounding their body.

(210.) If the validity of the foregoing comparisons are admitted,—and they appear to us as true to nature as any of those already brought forward among the more perfect vertebrated classes,—it follows, as a necessary consequence, that the families of the malacopterygious fishes follow each other in the same order, also, as do those of the *Cartilagines*. We have just glanced incidentally at the similitude between the flat fish and the rays; let us see, therefore, if this is merely fanciful, or founded in nature: a comparison of the two groups will determine this question.

Orders of Fishes.	Families of Malocopteryges.	*Analogies.*	Families of the Cartilagines.
Malacopteryges.	*Salmonidæ.*	Body lengthened; dorsal fins fully developed, one or two.	*Squalidæ.*
Acanthopteryges.	*Pleuronectidæ.*	Body depressed, flat, rhomboid.	*Raidæ.*
Apodes.	*Gadidæ.*	Tail long, nearly surrounded by the ventral fin.	*Chimæridæ.*
Plegtognathes.	*Siluridæ.*	Body mailed, teeth small; mouth with cirri.	*Sturionidæ.*
Cartilagines.	*Cobitidæ.*	Mouth beneath the muzzle; partaking of the cartilaginous structure.	*Prionidæ.*

We have already compared the primary orders of fishes with those of the great classes of the animal kingdom, and also with the families of the *Cartilagines;* nothing further, therefore, need be said on this subject, than to remind the reader, that these analogies give him a clue by which he can trace the most remote ramifications of these relations in the classes of birds and quadrupeds. In the present instance, nevertheless, we have introduced the orders of fishes in a separate column, to show more perfectly the wonderful harmony and *unity of design*—far greater than the wit of man could devise—which pervades these otherwise singularly varied groups. Here, in fact, we see that, by simply placing the soft-finned fishes in juxtaposition to the cartilaginous order, we have the *Pleuronectidæ* standing opposite to the *Raidæ,* as their *bonâ fide* representatives. The *Gadidæ* represent the slender-tailed *Chimæridæ,*—the latter being the *only* cartilaginous fish, yet discovered, having an eel-shaped tail—that is, gradually attenuated from the belly to a point, and bordered beneath by a long ventral. The mailed *Siluridæ* so completely represent the mailed sturgeons, that the *Loricaria rostrata* of Spix might easily be taken, at the first glance, for an *Acipenser;* and what is still more singular, the sturgeons, and the genera which represent them*, are the only

* *Squatina, Crossarchus,* &c.

family of the *Cartilagines* that have cirri or barbels to their mouth; these appendages being more developed among the *Siluridæ* than in any other fish in existence. The analogy of the *Cobitidæ* to the cartilaginous fishes has already been stated; and although their direct relation to *Prionodon* is far less apparent than any of those just noticed, still, if those are correct, it follows that either this or some other extraordinary type will effect the union. The *Prionidæ*, in fact, at present contain only two fishes; and it is yet undetermined whether these, like all the other *Cartilagines*, are viviparous: the probability is, that they really are so; and therefore even one such character is quite sufficient to show some relation to the *Cobitidæ*. This point, however, must yet be considered as debateable, until the real station of *Polypterus* is more clearly determined than it now is.

(211.) Lastly, it seems further desirable to test all these relations, by tracing the analogies of the *Malacopteryges* with the *Plectognathes*, or cheloniform fishes: the two circles, if placed in a linear series, will stand thus:—

Analogies of the SOFT-FINNED *and* CHELONIFORM FISHES.

Order of *Malacopteryges.*	*Analogies.*	Order of the *Plectognathes.*
SALMONIDÆ.	The fins with soft rays.	BALISTIDÆ
PLEURONECTIDÆ.	Dorsal fins with spines.	CHIRONECTIDÆ.
GADIDÆ.	Head broad; mouth very wide.	LOPHIDÆ.
SILURIDÆ.	Body covered with mailed scales.	SYNGNATHIDÆ.(?).
COBITIDÆ.	————	Unknown.

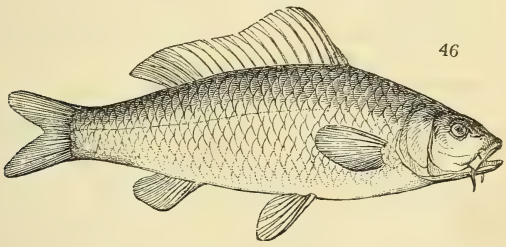
We have already adverted to the little diversity of form — in comparison to what we see in the two typical orders — that exists among the tortoise-formed group; and this fact at once accounts for their analogies being less obvious than many others. Certain, however, it is, that the *Salmonidæ* are as typical of one order as the *Balistidæ* are of the other, or the *Plectognathes:* the ugly aspect and unsymmetrical head of the *Pleuronectidæ*, again, find their representatives in the still more hideous *Chironectidæ;* and both have fins with

simple rays, and of little flexibility. *Raniceps*, among the *Gadidæ*, is a still more striking prototype of the common *Lophius piscatorius*, or fishing frog; an analogy so obvious as to be conveyed by their respective names. The mailed *Siluridæ*, forming the typical *Loricarinæ*, find their representatives among the cheloniform fishes, in the singular families of *Syngnathus* and *Pegassus*. Nor does their analogy rest alone on their external anatomy. Cuvier, as we have already shown, has separated the *Sygnathidæ* from all other fish, on account of their branchia assuming the form of tufts; and yet, although he is perfectly aware that the very same deviation from the ordinary branchia of fishes is found in another group, he merely considers the latter as only deserving of a simple generic distinction. The genus we allude to is that of *Heterobranchus* of Geoffroy Saint-Hilaire, which, in addition to the ordinary branchia, have others attached to them, resembling tufts, considerably ramified; so that these fishes combine the branchia of two distinct classes, namely, that of *Pisces* and of *Amphibia*. Among fish, their only prototypes, in this respect, are the *Syngnathidæ*, which, as we have already shown, are also the representatives of the amphibious reptiles. If primary divisions are to be made on such apparently anomalous characters, *Heterobranchus* has precisely the same claim for such a distinction as *Syngnathus:* but the fact seems to be, that this structure, far from being anomalous, is what we should expect in groups that stand at the greatest distance from their respective types; and from its thus occurring both in the *Syngnathidæ* and the *Siluridæ*, we discover that it is in perfect harmony with the usual course of natural variation, — a variation which frequently makes one group represent another in the most unexpected and singular manner. The cartilaginous type of the cheloniform fishes, if not *Polypterus*, appears to be undiscovered; and this may account for there being no group in that order which represents the *Cobitidæ*, which form the cartilaginous type in the circle of the *Malacopteryges*.

(212.) We shall now take a more particular view of the several families composing this order; always noticing the most remarkable or prominent forms in each, and occasionally pausing to trace the analogies of such as appear more particularly interesting, or as necessary to show the reasons of our arrangement being so different from those of our predecessors. The families will be reviewed in the same order as we have already noticed them, viz. — 1. the *Salmonidæ*; 2. the *Pleuronectidæ*; 3. the *Gadidæ*; 4. the *Siluridæ*; and, 5. the *Cobitidæ*.

(213.) The SALMONIDÆ, or salmons, appear to resolve themselves into five principal groups or sub-families, all of which are represented by the Linnæan genera *Cyprinus, Salmo, Clupea, Esox,* and *Mormyrus*. The few characters common to them all have been already intimated: where so much diversity of structure exists, a corresponding difference of habits will be found; and these had better be noticed under the separate divisions of the family.

(214.) The *Cyprinæ*, or carps, form a most extensive division of fish, entirely confined to fresh waters. Their numbers are much more abundant in the old world than in the new, and many species inhabit the rivers and lakes of temperate Europe. The carp (*Cyprinus Carpio* Linn., *fig.* 46.), perch, roach, and several



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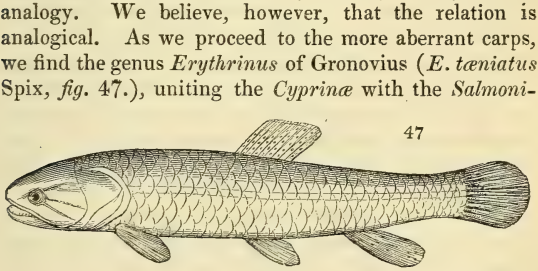
other native fishes, are familiar examples of the genera construction of the whole. They are the most herbivorous of all fish—feeding chiefly upon aquatic vegetables, like their prototypes the eels; to which, although

they have not the same shape, they appear really analogous: like them, also, they have thick fleshy fins, and a slimy mucous substance spread over their body: they further resemble the eels in having few or no real teeth, and both feed on the same substances. The mouth of the *Cyprinæ* is always very small, and the jaws destitute of teeth*; but they have strong powers of mastication, from the inferior pharyngeal bones being provided with a few large teeth, adapted for pressing their vegetable food: the stomach is simple, and without cæca. In external characters, they differ from the salmons, by having a single dorsal fin; the majority, also, have very thick fleshy lips, sometimes furnished with barbels†: the scales are generally large, the body ovate, the head thick and obtuse, and the ventral fin considerably behind the pectoral; it is generally, indeed, placed intermediate between the pectoral and anal. The characters of the two typical genera we have not yet clearly determined; but we suspect that the true *Cyprinæ* are almost peculiar to the Old World, and that *Catastomus*, with its sub-genera, represent them in America. *Cyprinus*, even as thus restricted, constitutes a very large group, which, notwithstanding the minute divisions that have been made among the European species, requires a complete revision. If the eighty-three species, which Dr. Hamilton alone has discovered in India, were to be divided on the same plan as has been done with those of Europe, those alone would amount to twenty or thirty sub-genera. Some of those proposed by Cuvier may be adopted, at least for the present; but we must confess our belief that his arrangement of this family is any thing but natural. The genus *Cyprinus* is distinguished from that of *Catastomus*, by not having the lips nearly so thick, or the under one hanging down and wrinkled in numerous folds; *Catastomus*, also, is entirely

* Except, of course, in the fissirostral type, or *Erythrinus* of Gronovius.
† These, in numerous instances, are so small as to escape detection; and from their being present or absent in species which have the greatest affinity to each other, cannot be made use of as exclusive characters, even for sub-genera. This is also the opinion of Dr. Hamilton (*Gang. Fishes*, p. 257.).

destitute of barbels, and the snout always projects beyond the mouth. Among the sub-genera of *Cyprinus*, which may perhaps be retained, is *Barbus*, represented by the common barbel of our own rivers; these processes, or cylindrical cirri, being placed on the sides of the mouth: with these we associate the gudgeons and the tench, as aberrant forms; but nothing definite can be determined on this point in the present state of their arrangement. The beautiful and masterly figures of Le Sueur of ten species of *Catastomus* may be consulted with advantage, both by ichthyologists and artists. The genus *Leuciscus* of Klein seems also to be one of the primary divisions of the carps: it is very numerous; but only one of its sub-genera has, as yet, been incorporated in our systems. Dr. Hamilton's genus *Chela* belongs to it, and others will be found in our Synopsis. The bleak, roach, and smelt, are all native examples; and they are at once distinguished from the two preceding genera, by their lips being destitute of barbels; and their thin fins, which are without the anterior spinal ray. Those that are found in India have such a strong resemblance to the herrings, as observed by Dr. Hamilton, that they are either related to them by affinity or by strong analogy. We believe, however, that the relation is analogical. As we proceed to the more aberrant carps, we find the genus *Erythrinus* of Gronovius (*E. tæniatus* Spix, *fig.* 47.), uniting the *Cyprinæ* with the *Salmoni-*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dæ, by their strong teeth and large mouth; while *Gonorynchus* of the same author somewhat resembles *Erythrinus*, with the small toothless mouth of a carp. Lastly, the most aberrant type may possibly be that of *Sudis*, a small genus of freshwater fishes found in the rivers of

tropical latitudes. They have, says Cuvier, "all the characters of *Erythrinus*," except that their dorsal and anal fins, both long and narrow, are placed close to the tail: he arranges them with the *Clupeinæ*; but they seem to us more naturally related to *Cyprinus* and *Salmo*. The last genus, *Sudis*, is remarkable for its lengthened cylindrical body, covered with large osseous scales, indicating its analogy to the cheloniform fishes, and to the flat-headed *Siluridæ*: its mouth opens somewhat vertically, as in *Chironectes* and *Uranoscopus*; and on these grounds we suspect it is the type of all these fishes in the present sub-family: only three species have yet been found.

(215.) The *Salmoninæ*, or salmons, have many close relations to the carps; nevertheless their larger mouth, their thin lips, and well-defined teeth, show that their food and economy are very different. In this division are arranged all such fishes of this family as have a small adipose dorsal fin, placed half-way between the first dorsal and the caudal. We do not feel confident, however, for reasons hereafter stated, that this is a truly natural arrangement; although, in the present state of ichthyology, it is a very convenient one for discriminating the genera. The different groups of salmon are distributed more abundantly in the Old than in the New World: the history of those that are common to our own country has been repeated so often as not to require notice in this place. The salmon, salmon trout, and chars are well known for their rich and delicate flavour: the first, more especially, produces a source of much wealth to those concerned in its fishery.

(216.) It is evident, that if *Erythrinus* is to be placed among the carps, on account of its single dorsal fin, it must be an aberrant type; and whether we ultimately assign it to that circle, or to the one now before us, it forms a link of connection between the two. There are two or three very remarkable sub-genera of fluviatile fish in the rivers of Tropical America, which seem to have as much of the aspect of perch as of salmon: they

have a very small mouth, and thick lips; but some have strong teeth; and all have a small adipose fin. These appear to form one of the primary divisions of the *Salmonidæ*, and to be further distinguished by their geographic distribution, which is confined to the New World; while the genuine salmon, and its sub-genera, are more particularly appropriated to Europe, and the more temperate latitudes of Asia and America. Among these first we may glance at *Serrasalmo*, remarkable for a thick, oval, and high body, and very large triangular cutting teeth; the belly is compressed, and serrated like the edge of a saw, from whence their name. These fish, like *Erythrinus*, may be called the sharks of their own family; and they are stated to be so fierce, that they will destroy water-fowl, and even attack the Indians when bathing in the rivers, although, from their comparatively small size, they can only inflict wounds in the flesh. The other sub-genera belonging to this group are *Myletes* (Cuv)., *Tetragonopterus* (Artedi), which have the belly serrated; and *Characinus* (Artedi*), *Leporinus*, *Anodus*, and some other aberrant forms or species, which have small mouths and more delicate teeth: one or two, indeed, have no teeth whatever in their jaws; while, in the very small size of the mouth, and the thick lips, they have all the aspect of carps, but with a small adipose fin. In the European division, we have the common salmon, the trout, and the char: in these, the body is more lengthened, the mouth moderately wide, the lips thin and bony, and the teeth small, edging the margin of the jaws: many sub-genera have been proposed, among which is *Osmerus* of Artedi, which includes the small salmons called smelts. *Coregonus*, of the same excellent ichthyologist, seems to represent, in Europe, the salmons of Tropical America; for their mouth is very small, and the teeth are frequently wanting: they are chiefly found in the continental lakes. The *Argentina* of Linnæus is a small

* Subsequently called *Curimata* by Cuvier.

semi-opaque fish, long celebrated for its richly silvered swimming bladder; it is so brilliant as to be seen through the body, and has long been used in the manufactory of false pearls. Hitherto we have noticed only such salmon as have a small, or, at least, only a moderate sized mouth: but there is another race, whose food must be entirely animal; the mouth is excessively large, the gape opening far beyond the eye; and the sides of the jaws, as well as the inside, are armed with long slender teeth, of different sizes, and moving backwards at their roots: this gives them an appearance of being flexible, but they are not so; for if an attempt is made to bend them forward, they become as firm and hard as if they were rooted in the jaw: such is the nature of the teeth in the genus *Laurida* of Aristotle, which was the *Salmo Saurus* of Linnæus.* The use of this structure seems to be, that the fish may swallow its prey at once, and that it may glide down the throat without being impeded by the numerous teeth it meets with in the passage. The enormous gape, indeed, of these fishes, shows that they swallow others of a disproportionately large size; and the teeth, being so very slender and acute, are only used for the purpose of capture. One species, the *Salmo Saurus*, of the old writers (*Laurida Mediterranea* Sw.), is found in the Mediterranean, and presents no very marked difference in structure from others found by Spix in the Brazilian seas: the head is covered with strong bony plates, or, rather, it appears to be naked; and the scales are firm and hard. The *Lauridæ* are also generally remarkable for the smallness of the pectoral, and the great size of the ventral fins. Although marine fishes, they have an evident relation to *Erythrinus*, in their round and cylindrical body, large mouth, and bony head; as well as to the true salmons of Europe; the former being a

* M. Cuvier has not only rejected the classic name given by no less a naturalist than Aristotle to this group, but uses one (*Saurus*, a lizard), which, under any circumstances, is totally inadmissible; we may just as well employ *Avis*, *Amphibia*, *Reptilia*, &c. to designate ichthyological genera.

relation of analogy, while the latter is obviously one of affinity.

(217.) The foregoing observations will give the general reader some idea of the most remarkable fish included in the two typical divisions of the *Salmonidæ:* but this manner of treating the subject is so dry, and so little calculated to excite the attention of the naturalist, that we shall now attempt to investigate the whole, with reference to the natural series, and to the different relations of the minor groups. True it is, that our analysis has not been carried so far into this family as into many others; and therefore we must have recourse to that mode of investigation already explained.* This has partly arisen from the insufficiency of those characters which have been given to the numerous sub-genera recently proposed, the majority of which are made to rest entirely on the shape of the teeth: thus it is that natural groups have been broken up into smaller ones; and these being all considered of the same rank, subordination in their value has been lost sight of. If the teeth are really of such primary importance in classification, why are they viewed so in one instance, and not in another — not in different orders and families, but in the same genus? Why, for instance, is *Myletes* to be separated from *Serrasalmo* solely "on account of their teeth," when, in the very next sub-genus, *Hydrocyon*, M. Cuvier states that "some have a crowded range of small teeth on the maxillaries and palatines; others, a double range on the intermaxillaries and lower jaw, and none on the palatines; others, a single range on the maxillaries and lower jaw;" and, finally, "others have absolutely no teeth whatever, except on the intermaxillaries and lower jaw." Here, then, is a group confessedly varying in the teeth of almost every species, yet to which no definite characters, taken from the shape or fins, are given, by which the naturalist can possibly comprehend the extent of the author's meaning. For our own parts, we confess our perfect inability to compre-

* Page 3. (2.)

hend, from the definitions in the *Règne Animal,* the greater part of the sub-divisions of the old genus *Characinus,* proposed by its learned author, — a genus which is really abolished, although nominally retained. We are obliged to make this exposition of the utter insufficiency of such characters, in justification of our opinion, so often expressed and acted upon, on the secondary value of M. Cuvier's dental system, and of the inconsistency, seen in the examples just quoted, of employing and rejecting such characters in two genera absolutely placed close to each other. To act in opposition to high scientific authority, without assigning reasons, implies not only great presumption in the dissentient, but contempt towards his predecessors.

(218.) On taking a comprehensive view of all those genera which accord, more or less, with the characters assigned to this numerous division, and placed in it by M. Cuvier, we shall have no difficulty in determining that *Salmo*, *Characinus* (Artedi), *Xiphostoma*, and *Sternoptyx* are the most prominent or dissimilar types of form among all those which have an adipose dorsal: to these, for reasons which will afterwards appear, we shall add *Sudis,* placed by M. Cuvier between *Amia* and *Osteoglossum* (Vandel.). We shall now endeavour to assign to each of these their determinate characters, and to assemble the minor groups under those to which they appear most allied. The two typical divisions appear to be *Salmo* and *Characinus;* while the three aberrant are here considered as *Xiphostoma*, *Sternoptyx,* and *Sudis.*

(219.) The genus *Salmo,* with its subordinate types or sub-genera, first claim our attention. In this group we include all those divisions of Cuvier, whether they are called genera or sub-genera, which more or less agree with the general structure of the salmons, chars, and trouts of Europe. On generalising the characters of these fishes, it will be observed that the body is of a lengthened oblong shape; the head small, and the muzzle narrow and rather pointed, without being length-

ened: the two jaws are of nearly equal thickness, or, rather, the under one is narrower and weaker than the other: the mouth is wide, and cleft in nearly a horizontal direction: the first dorsal fin is in the middle of the back; while the anal fin is so short, as rarely to be longer than the breadth of its anterior. These characters may be seen in full perfection in the salmon (*Salmo*), with which we include the smelts (*Osmerus*) and *Corygonus: Mallotus* has them only in part; the chief deviation being in the anal fin, which is more lengthened. The true genus *Laurida* of Aristotle, as well as *Anastomus* of M. Cuvier, complete the divisions of this genus. We consequently do not adopt *Thymallus*, or admit that the smelt is any thing more than an aberrant species of *Salmo*, just as *Aulopus* is of *Laurida*. Thus circumscribed, the European salmons with short anal fins are all referrible to the following sub-genera, viz. *Salmo*, *Laurida*, *Anastomus*, *Mallotus*, and *Corygonus;* the affinities and relations of which appear to be as follows.

(220.) The European salmons, forming the genus *Salmo*, have a small sharp head, with a mouth so large as to have the gape often extending beyond the line of the eye. The first dorsal is nearly central, and the ventral immediately under it; the anal fin, in like manner, corresponds in its situation to the second or adipose dorsal; while the pectoral is small, pointed, and placed very low down towards the throat. The teeth are very numerous in all; being placed, generally, on all the maxillary bones, the palatines, and the vomer: in some species, like the smelt, there are very few teeth in the latter part; and the lower jaw, in both sexes, is longer than the upper; but as this is a typical group, such slight variations are always to be expected. In the *Salmo tumbil* (Bloch, 436.), we have the first material deviation from the typical characters. The pectoral is placed higher up towards the back; the ventral fin is before the first dorsal; and although not greatly developed, is yet as large as the pectoral: the lower jaw, as in the smelt

(*Salmo Eperlanus*), is longest; but, in all other respects, the head of this fish is a compound of *Salmo* and *Laurida*,—two genera widely separated by Cuvier, but which actually pass into each other in the most gradual manner: the *Salmo fœtans* (Bloch, pl. 384. f. 2.) brings us, in fact, at once into the genus *Laurida* (*Laurida Mediterranea* Nob., *fig.* 48.), the peculiar and discriminat-

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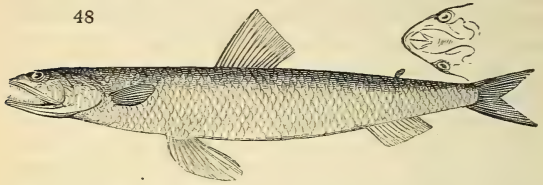

ing character of which is, that the ventral fin is so much developed as to be considerably larger than the pectoral, near to which it is placed,—and not, as in *Salmo*, immediately under the first dorsal. Some of the *Lauridæ* of America (*L. microps*, *fig.* 49.) have the eyes very

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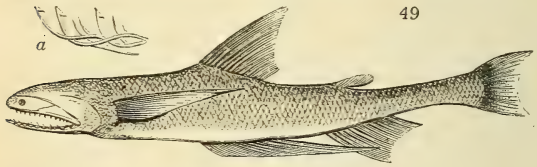

small, and the teeth (*a*) crooked and hooked, or, rather, half barbed; the mouth being excessively wide: while the jaws in others are unequal. In all, however, the sides of the head are covered with scales, and the ventral fin is very large. For convenience we may retain the subgenus *Aulopus*, although it consists of but a single species, and has such a close resemblance in most parts of its structure to *Laurida*, that it seems to us to belong to the same generic group. M. Cuvier supposes this fish to connect the salmons with the cods; but we

do not see in what manner it bears any relation to the *Gadidæ*, in any other respect than its small teeth. It has the large and firm scales, the ample ventrals, the small pectorals, and the adipose dorsal of *Laurida;* from which it chiefly differs in the smallness of the teeth, and in having (like *Laurida microps* Sw.) the ventral placed immediately under the first dorsal; two characters which bring it closer to *Salmo* than to any other group. The singular protrusion of the point of the chin, in the lower jaw, establishes a remote relation of analogy between *Aulopus* and *Sphyræna;* and all these circumstances tend to confirm us in the views we have taken on its true affinities. It should here be observed, that as *Laurida* stands as an aberrant group, so we find it loses one of the typical characters of the European salmons, and begins to assume another of the American ones: the anal fin, instead of being short, is always longer than in *Salmo;* and the teeth differ from all others of the group, by being excessively crowded, of unequal lengths, and pointed or moveable at their roots. The two groups appear connected by such fish as *Laurida minuta* (*fig.* 50.), where the anal and ven-

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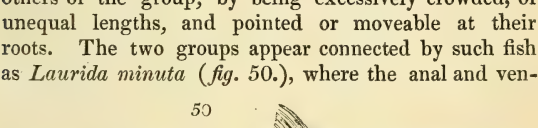

tral fins more resemble those of the true salmons. The species of *Laurida* are not numerous, and appear to be altogether marine, without growing to more than two or three feet in length: they do not ascend or enter freshwater rivers, like the salmons; but, being oceanic, are found both in the Mediterranean and Atlantic Oceans. Following *Laurida* we place the genus *Anastomus* Cuv.; not because there are any species of one or the other which evince any affinity to each other, but because this is the only genus which, possessing the

short anal, and some other characters of the European salmons, has the mouth completely vertical. It will be seen that, throughout all the natural groups of ichthyology, one type with the mouth opening vertically is always to be found; and this variation is so prevalent, that whenever it is met with, we may be almost sure it is the chironectiform type of that circle of which, in all other respects, it possesses the leading characters. M. Cuvier has, therefore, very judiciously made the *S. anastomus* of Linn. (*fig.* 51.) the type of a genus distinct

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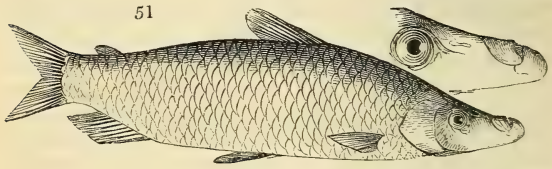


from that of *Gasteropelicus*, although he was not aware of the reasons which induce us now to adopt it. In all other respects but its narrowed head, and very small vertical mouth, *Anastomus* has the general shape of the true salmons; the size, form, and relative proportion of the fins being the same: it cannot be said, however to have the "form of the *S. Thymallus*," because the first dorsal fin is not at all lengthened; nor is it so proportionably high as in that fish. We next come to the sub-genus *Mallotus*, which has also the general structure of *Salmo*, but with the remarkable character (unique in this group) of rounded pectorals; all the other salmons having these fins pointed. Only one species of this singular type is known, — the *Mallotus Grœnlandicus*, or Greenland salmon, — which Bloch (pl. 381.) describes as a small fish, mostly used as a bait for cods. This type has the further peculiarity of the tail or caudal fin not being symmetrical with the pectoral; the latter being rounded, whereas the former is forked; while the anal is more lengthened than in any of its congeners;

the teeth, as in *Anastomus*, are small and crowded; and the lower jaw is even longer than the upper one, although the form of the head is like that of the ordinary salmon. The transition from this type to *Coregonus* * (Artedi) is beyond dispute. Cuvier, in fact, makes them to follow each other, with the intervention, indeed, of the *Coregonus Thymallus*, or the grayling, which he places as a distinct sub-genus; but which we consider the most typical example of the genus from which he has separated it. In this view we only adopt the opinion of Artedi, and, more recently, of Dr. Richardson. *Coregonus*, then, is composed of the graylings, well distinguished from the true salmon by having a very small mouth, furnished with a few slender teeth, which are altogether wanting in some of the species: the under jaw is always the shortest; and the gape of the mouth is before, instead of behind, the line of the eye: in all other respects the general structure is completely similar to that of the large-mouthed salmons; so that, having returned to the type we originally commenced with, we may place the whole in a column, and trace the analogical relations of the series to the primary orders.

Sub-genera of SALMO.	*Analogies.*	Orders of FISHES.
Salmo.	Typical, being the most highly organised.	ACANTHOPTERYGES.
Coregonus.	Sub-typical.	MALACOPTERYGES.
Mallotus.	Body lengthened; pectoral fins rounded.	APODES.
Anastomus.	Mouth very small, opening vertically.	PLECTOGNATHES.
Laurida.	Voracious; mouth large; head depressed.	CARTILAGINES.

If the question was asked, whether *Salmo* or *Coregonus* was the most highly organised group, no difference of opinion could possibly arise; because a fish that has all the parts of its mouth well armed with teeth is unquestionably more perfect, that is, of a superior organisation to one that has few or none of these organs: now, this is just a parallel case with the *Acanthopteryges* and the

* This genus was founded by Artedi,—not, as is supposed, by Cuvier.

Malacopteryges, or the spiny and the soft-rayed orders. Other analogies may possibly exist, but these are quite sufficient for our present purpose. *Mallotus*, it will be remembered, is the only division of these salmon which possesses very ample rounded pectoral fins; and the apodal is the only order to which, from this structure being absolutely universal, this type can be compared. It is further remarkable, that *Mallotus* has the body very much lengthened,—another point in which it shows an analogy to the eel-shaped fishes of the apodal order: the length of the anal fin (always more developed in this than in any of the primary types of fishes) likewise favours the supposition that *Mallotus* is the anguilliform type of the salmon. The analogy of *Anastomus* to the *Plectognathes* is so evident, that no additional illustration is necessary. There now remains only *Laurida*, which stands opposite to the cartilaginous order. If any of our readers wishes to be convinced that these are the sharks of the salmon race, let him look at the head of one of these species (*fig.* 48.), and, without being exactly able to explain in what this analogy consists, he will be convinced that it is founded in nature. One important character of these salmon, not mentioned by our predecessors, is the great flatness of the head, and the almost vertical position of the eyes: the formidable nature of the teeth, which, in comparison to the size of the fish, are excessively large, is another of the many points of resemblance between *Laurida* and *Squalus*, and this is accompanied by that destructive warfare which each, in its way, carries on among other fishes. Thus we see that the theory of analogy confirms our disposition of these groups, and sanctions us in rejecting several of the sub-genera of the *Règne Animal*.

(221.) To give additional support to our present arrangement of the foregoing fishes, we shall now compare them with the primary divisions of the entire family of *Salmonidæ*, in which, it will be remembered, we also bring in the herrings (*Clupeinæ*), the pikes (*Esocinæ*), the snout-fish (*Mormyrinæ*), and the carps (*Cyprinæ*).

On placing these two groups together, we shall get the following mutual resemblances :—

Sub-genera of SALMO.	*Analogical Characters.*	Sub-families of the *Salmonidæ*.
Salmo.	The pre-eminent type of the	SALMONINÆ.
Coregonus.	Teeth very small or none; mouth small.	CLUPEINÆ.
Mallotus.	Pectoral fins rounded.	CYPRINÆ.
Anastomus.	Muzzle produced; mouth terminal, very small.	MORMYRINÆ.
Laurida.	Head flattened; mouth very large; teeth long, sharp, slender, exceedingly numerous.	ESOCINÆ.

Our restricting the typical salmon to those with large mouths and numerous teeth, makes them representatives of the whole family, so that nothing further need be said in confirmation of the first analogy. The small mouth, never cleft beyond the eyes, with the scales much larger than in the true salmon—setting aside the general appearance of the fish—renders *Coregonus* a perfect representation of the *Clupeinæ*, or herrings: hence the specific name of *Clupeoïdes*, given by Pallas to one of the species. Again, Mr. Yarrell observes, the appearance of the gwyniad (*Coregonus fera*) "is not unlike a herring. Indeed, the common people of the lakes where this fish is found, call them the freshwater herring, and preserve them in the same manner, with salt." Facts like these are always valuable; for there must always be something real in resemblances that have acquired popular credence. A rounded pectoral fin is as prevalent among the carps (*Cyprinæ*) as a pointed one is characteristic of the salmon: we may therefore compare *Mallotus* with the carps, for it is nearly the only salmon * possessing this analogical character. There may, indeed, be some doubts on this analogy; but there can be none with regard to the next, or that between *Anastomus* and *Mormyrus;* for the former has quite the incipient trumpet-shaped snout of the latter, while in

* The parr or samlet (*Salmo Salmulus*), so ably determined as a distinct species by Mr. Yarrell, is represented, indeed, with rounded pectorals; but as no mention is made of this unusual deviation in the description, some uncertainty hangs on the subject. I have never seen this fish. See Yarr. Brit. Fishes, vol. ii. p. 42.

every other character it is a true salmon: this analogy, in fact, is particularly strong, yet not more so than that between *Laurida* and the *Esocinæ*, or pikes. Both these have enormous mouths, presenting, when opened, a forest of teeth of all sizes, and in all the internal parts; so that the *Lauridæ* are the pikes of the sea, as much as *Esox* is of the fresh waters. This result, which is the consequence of restoring *Laurida* to its natural situation, close to the typical salmon, is exceedingly interesting, because it establishes the two most obvious analogies: one being remote, as to the sharks; the other approximate, being to the pikes. We look on this part of our arrangement as the most certain affinity in the whole series: and we shall now proceed to the next group.

(222.) To the second great genus of the salmons we retain the original name of *Characinus*, given to the majority by Artedi. The number and variety of these are even greater than those of the last genus; but they are all natives of Tropical America. Unlike the European salmon, the majority of these fish are short and deep in the body, so that some assume the discoid form of the flat fish: the mouth is short and very blunt; and although not wide, is moderately large: the commissure, instead of being straight and nearly horizontal, is considerably angulated, and obliquely vertical. They are further distinguished from the European types by the superior length of the anal fin, which is generally four or five times as long as it is broad; whereas, in the genus *Salmo*, this fin is always short, at least in the typical examples. The only exception to these characters occur in certain Brazilian river fish, placed by Spix and Agassiz in the sub-genera *Curimata, Leporinus, Anodus*, and *Prochilodus:* these are all of an oblong shape, much like that of *Coregonus*, which they further resemble in the shortness and breadth of their anal fins, and the smallness of their mouth. The natural station of these sub-genera, and their relative rank, is too difficult to allow of our arriving at any certain conclusion:

M. Cuvier places them all in his sub-genus *Curimata;* but although some, as *C. fasciatus* (Spix, pl. 36.*), evince a resemblance to *Anastomus,* by their slender snout, and excessively small mouth, almost vertically cleft, it is very questionable whether *Prochilodus* is also allied to the others: two species are figured by Spix, which, in their small mouth, thick fleshy lips, and absence of teeth, no less than in their body and fins, perfectly agree with the carps; the only difference being a very small adipose dorsal, placed immediately above the short anal. We see no possible affinity between these singular fishes and the *Salmo Thymallus,* with which M. Cuvier has compared them: they have not, as in that, the first dorsal fin high, long, and unusually developed; it is, on the contrary, of the same size as the ordinary species of *Coregonus;* and we feel by no means sure, whether the majority of the above-named salmon, although natives of South America, should not be placed with the European group. On the other hand, it must still be remembered, that all these tropical salmon differ from ours, in having no teeth on the tongue; and that the number of rays in their gill membrane is rarely more than four or five: the wide separation, also, of the latitudes they respectively inhabit, must not be overlooked; so that, upon the whole, we may safely conclude them to be the American representives of *Coregonus,* just as *Catastomus* is, in the New World, of the European and Asiatic *Cyprinæ.* Now, with the exception of these fishes, the whole of those now under consideration agree in having the characters already assigned: that is to say, the snout is short, thick, and obtuse; the mouth angulated; and the anal fin more or less lengthened. From all the divisions made by Cuvier of Artedi's genus *Characinus,* we select the following as the most dissimilar to each other, and these we consider as types of form, viz. *Characinus* Artedi, *Serrasalmo* Lac., *Chalceus* Cuv., *Gasteropelicus* Bloch, and *Cynodon* Spix and Agassiz. In this selec-

* Also *Anodus latior,* pl. 41., and *A. elongatus,* pl. 40., of the same author.

tion we have been guided entirely by outward structure; since the different modifications of the teeth, as M. Cuvier himself confesses, "are varied in the most surprising manner;" so that almost every species differs from its congener, and proves the utter futility of attempting to make them the bases of generic characters. Now, as the form of the body and fins partakes also, in some degree, of this unusual variation, it may be better to view this division as assuming the rank of a sub-family, and to consider the above-mentioned groups as genera, rather than as sub-genera: this will enable us to specify the minor types, and to designate them, we hope, in a more comprehensible manner than has hitherto been done.

(223.) The *Characinæ*, or tropical salmon, appear typically represented by the genus *Serrasalmo* of Lacepede. These are a group of large, stout fish, whose depth is more than half as much as their length: the snout is blunt; the head small; the gills very large, bony, and naked: the mouth opens obliquely downward: the upper jaw is small; but the lower one is excessively thick and strong, being armed with sharp triangular cutting teeth double the size of those in the upper jaw: the pectorals are placed very low, close to the belly; and the ventrals, which are only half as large, are immediately under the first dorsal fin; and both these latter are pointed: the anal is long, broad in front, and gradually narrowed behind: the scales are small; and the belly is sharp and dentated like the teeth of a saw: in some, as in *S. nigricans* (Spix, pl. 30.), there is a very short procumbent spine, pointing forwards, at the base of the first dorsal; while, in others, as in *S. ferox* Nob. (Spix, pl. 28.), these anterior spines point backwards, and three or four of the first dorsal rays are spinous. Those fishes which form the sub-genus *Myletes* Cuv., have all the above characters, except that the procumbent spines are wanting, the teeth are blunt, and the upper jaw is strongly angulated. The sub-genus *Tetragonopterus* of Artedi differs only from the last in

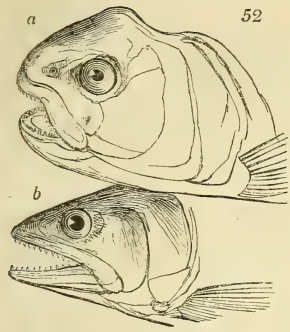
its mouth, which is smaller; in its teeth; and in not having the belly carinated. These are followed by *Chalceus*, which differs materially from all the foregoing, by having the hinder part of the body lengthened, and the pectoral fin so long as to reach to the vent: the unusual development of this fin, as seen in *C. angulatus* (Spix, pl. 34.), is very remarkable, and deserves much attention, because it will materially help to determine the station of this type in a natural arrangement. We retain the original generic name of *Characinus* to those which have been subsequently called *Curimata* by Cuvier. These fishes, whose teeth vary in almost every species, are nevertheless readily distinguished from all the other salmons, by their elongated form, by the smallness of the mouth, and, more especially, by having the anal fin as short as any of the European salmons: their external similarity, in fact, to *Coregonus*, indicates a clear relation of analogy, if not of affinity. Following these we place *Piabucus* Cuv., which has the general shape, mouth, &c. of *Characinus*, but differing in the anal fin being very long. Allied to all these small groups, is that of *Gasteropelicus*, — a singular little fish, having the shape of *Serrasalmo*, but with the belly remarkably protruding; while the head is so raised upward, that the mouth becomes completely vertical: the anal fin, as in the majority of these groups, is very long and narrow; and the belly sharp, without being serrated. Finally, we come to the genus *Cynodon* of Spix, whose aspect is altogether different from any of the preceding fishes: the head is large; and the wide mouth, which opens downward, is armed, as in *Laurida*, with long slender teeth of different sizes: the body is lengthened, and the anal fin is uncommonly long. The two very remarkable species figured by Spix*, are included by Cuvier in his genus *Hydrocyon*; but this group contains such a heterogeneous assemblage of fishes, with little or no affinity to each other, that it would almost seem to have

* *C. vulpinus*, Spix, pl. 26.; *gibbus*, pl. 27.

been made a receptacle for all such salmon as could not be arranged under the other divisions: for this reason we cannot possibly adopt it. The genus *Citharinus* of the same author is so slightly defined, that we can form no idea of its true affinities; it seems to have both the adipose fin, and the greater portion of the caudal, covered with scales: as this latter character belongs to some species of *Cynodon*, we may presume, not having seen an example, that they are in some degree related.

(224.) We have now enumerated the greater part of those American salmon, which, from having the anal fin lengthened, will enter into our definition of the CHARACINÆ. Without venturing to determine the value of this group collectively, or even to separate the subgenera from the genera, we are yet led to believe that this is by no means an artificial assemblage: the natural succession of the types may possibly prove different from that series in which we have arranged them; and even some, as already hinted, may be found eventually to belong to other divisions: and yet, with all these difficulties and uncertainties in our way, there is some reason to believe that the *Characinæ* really contain representations of the *Salmoninæ:* and that a little attention to the peculiarities of the forms in each will materially confirm this idea, will be apparent from the following considerations.

(225.) In the first place, it will be observed, that the most typical salmon of Europe are those which, like the common species, have a widely cleft mouth (*fig.* 52. *b*), with the jaws, and all the bones of the palate and throat, covered with teeth; so much so, indeed, that Cuvier has well observed, "they are the most completely dentated of all fishes." Now, if we look to the American salmon, we shall find that the extraordinary development of these organs takes place likewise in the *Serrasalmi:* the teeth of these ravenous fishes are as formidable, in size and structure, as those of the sharks; taking into account the relative size of the two races: the tongue, indeed, in those of the American rivers,



is smooth; but then the teeth of the jaws are large, triangular, cutting, and dentated: in some, indeed, as in *Myletes* Cuv., the teeth are so strong as to be employed in mastication. The form, number, and situation of these teeth vary in a remarkable manner; but, from being present in all the species and sub-genera, we may at once decide that the *Serrasalmi* are the most perfectly dentated of the American division, just as the true salmons are of such as occur in Europe. The affinity between *Serrasalmo* and *Characinus* (*fig.* 52. *a*) is as intimate, according to the way in which Cuvier has placed them in his system, as that which unites *Salmo* with *Coregonus:* now, the teeth in both these groups are always smaller and fewer than in the two preceding; they have both a small mouth; the scales of both are larger; and in both, the teeth are often altogether wanting: this resemblance, in fact, between the two is so strong, that we might almost think they were united by affinity, because it will be remembered that the different types of *Characinus* are the only fishes among the American salmon which have the anal fin short. There is, however, a peculiar aspect about these latter, by which the practical ichthyologist will readily detect them, independent of their geographic range, and the remarkable difference in the number of the rays to the gills. In *Coregonus,* these rays amount to seven or eight; but in *Characinus,* and all the American salmon, they do not exceed, according to the best authorities*, more than four or five; nor have the American fishes any teeth

* Artedi, Cuvier, Bloch: the former chiefly founded the genus on this very peculiarity.

upon the tongue. Let us next compare *Piabucus* and *Mallotus*. Of all the types of the *Characinæ*, *Piabucus* is that which has the longest anal fin, which, in two out of the three species figured by Bloch*, is equal to one half the length of the body. Now it will be remembered that *Mallotus* is the only type of the European salmon having this fin very conspicuously lengthened. The pectoral fins of both are more than usually developed; but in one they are pointed, and in the other rounded: while the two types, in other respects, are sufficiently distinct to check any suspicion of their being any real affinity between them. The slight protuberance of the belly in *Piabucus argentinus* appears an indication of its being followed by *Gasteropelicus*, which, in the vertical position of its little mouth, is such a complete representation of *Anastomus*, among the true salmon, that whatever may be the situation of the two, they must always stand as representatives, not merely of each other, but of all the chironectiform types in ichthyology. There yet remains the singular genus *Cynodon*† of Spix among the American salmon, which differs from all others by the excessive wideness of its mouth, armed with long, slender, pointed teeth of various sizes. Its long anal fin shows its relation to *Characinus*, and the slight protuberance of its belly to *Gasteropelicus;* but if these two peculiarities are set aside, the reader will immediately recognise in the foregoing description a counterpart of *Laurida*, whose wide mouth and long slender teeth are altogether unique among the salmons of Europe.

(226.) That the above analogies may be brought together at one view, we now subjoin the annexed table, leaving it for future ichthyologists to determine the rank of the different groups it contains.

* *P. argentinus*, Bl. 382., fig. 1.; *bimaculatus*, ib. fig. 2.

† The genus *Synodus* of Gronovius is supposed by Cuvier to rest upon a fish which he thinks is a *Laurida*, whose small adipose [dorsal had accidentally been omitted by the artist, or broken in the specimen. This may possibly be the case; and yet the remarkable correctness of all the figures of Gronovius, and his great accuracy as an ichthyologist, renders it equally probable that this figure represents a fish unknown to modern ichthyologists.

Analogies of the EUROPEAN *and* AMERICAN SALMON.

American Salmon.	*Resemblances.*	*European Salmon.*
CHARACINUS *Artedi.*	Mouth small; teeth minute, often wanting.	COREGONUS *Art.*
SERRASALMO *Lac.*	Mouth larger; teeth strong, numerous.	SALMO *Linn.*
CYNODON *Spix.*	Mouth excessively large; teeth long, slender, unequal.	LAURIDA *Arist.*
GASTEROPELICUS *Bl.*	Mouth small, vertical.	ANASTOMUS *Cuv.*
PIABUCUS *Cuv.*	Anal fin very long.	MALLOTUS *Cuv.*

(227.) We now come to the three aberrant types of this sub-family, represented, as we conceive, by the genera *Xiphostoma* Spix, *Sternoptyx* Herm., and *Sudis* Cuv. The first of these is represented by one of the most singular forms among the salmons; and so strongly does it recall to our mind the form of the *Xiphias*, that it may be termed the sword-fish of the salmons. It will be seen, from the annexed cut (*fig. 53.*) that the

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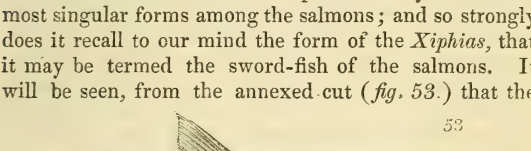

body is elongated; and although both jaws are considerably lengthened, the upper one slightly exceeds the other, and terminates in a small but very distinct point: the angulated upper jaw, so conspicuous in the last group, is also continued to this, and there is a small adipose fin; here, however, all similarity between them ceases. The first dorsal fin is placed much nearer the caudal, and both that and the adipose fin are situated rather behind the ventral and anal: the teeth are very remarkable: being all equal, with their points directed backwards: the ventral and anal fins are triangular, and of equal size; while the hard compact scales, marked with longitudinal elevations, remind us immediately of *Laurida*. In the sub-genus *Hepsetus* Sw., which includes the African or Old World representatives of the American *Xiphostomi*, the jaws, although narrow and

rather attenuated at their tips, when viewed laterally, are nevertheless considerably wider above; but they are not lengthened: both are equal, and armed with sharp slender teeth of unequal sizes. In these fishes, the first dorsal is still further removed from the head than in *Xiphostoma*, and the upper jaw is more angulated: the appearance of all these fish reminds us so much of pikes, that they may be termed pike-salmon: but few species are known, and they all appear to inhabit the tropics of the Old World.

(228.) The genus *Sternoptyx* is one of the most singular forms in this or any other order, and yet it is by no means so anomalous as its first aspect might tempt us to believe. Let the reader only imagine a highly exaggerated figure of *Gasteropelicus*, and he will have a very good notion of the general shape of these singular fishes. We are not aware of any other figures of the two species already described, than those which are to be found in most works, copied from Hermann; and on this account we regret the more that several specimens of two other new species we discovered in the Mediterranean, and deposited in the British Museum, are now no longer in existence: as we depended upon these for subsequent descriptions and drawings, we are compelled partly to transcribe what Cuvier has said of the species known to inhabit the warm parts of the American coasts, for hitherto no one appears to have detected them in the Mediterranean. The annexed cut

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(*fig.*54.), copied from the rude figure of Hermann, will tend to elucidate the following anatomical description given by Cuvier. These fishes, he observes, have a very deep and considerably compressed body, with the mouth directed upwards: the humerals form a sharp ridge in front, terminated below by a small spine; the

bones of the pelvis form another, also terminated below by another small spine, in front of the ventrals, which are so small as to have been formerly overlooked: along the ridge of the pelvis, on each side, is a series of small fossettes, which have been regarded as a festooned fold of the sternum, and has given rise to the generic name. In front of the first dorsal fin is an osseous or membranaceous ridge or crest, which appertains to the anterior interspinals; and behind this fin is a small membraneous projection, which represents the adipose fin of the salmons: the sides of the mouth are formed by the maxillaries. Of the two described species, *S. diaphana* has small, even, and crowded teeth, and five rays to the gills: its form is singularly oblique, for the mouth projects beyond the ventral line. The other, *S. Olfersii*, has hooked teeth, and nine rays to the gills. The Sicilian species, before alluded to, is so exceedingly rare, that we only met with them twice during six years, and both times in the same situation, cast up on the shore opposite Reggio, in the Straits of Messina, after violent storms: on one of these occasions, near a dozen specimens were found, most of them much broken by the action of the surf: excepting for their bones, they would have been little thicker than a wafer, and their colour was of the most brilliant silver. In all probability they live in very deep water, for their whole structure is analogous to that of some of the riband-fish, the eyes being excessively large, and the fins very brittle. We remember comparing them with the descriptions in Shaw*, and observing some differences; but depending on the power of describing them hereafter, we neglected taking any notes; and the specimens being now lost, as already stated, further information upon them, from us, at least, becomes impossible.

(229.) The singular genus *Sudis* is placed by Cuvier in the herring family (*Clupeinæ*), close to *Erythrinus* and *Amia:* it has an evident affinity with the two last,

* Shaw, probably on the authority of Hermann, states that there is no gill membrane. — *Gen. Zool.* vol. iv. p. 112.

but we cannot discover any relation it bears to the herrings,—even in a solitary character: its depressed head, large mouth, and strong teeth, and even something in the position of its fins, would lead us, in the first instance, to arrange it among the pikes (*Esocinæ*); its relation, however, to *Erythrinus* appears, upon the whole, more close; and as we have placed this latter genus as an aberrant form in the circle of the *Cyprinæ*, so do we arrange *Sudis* as the connecting link between the salmons and the carps. Whether this is its true situation in nature, it is impossible, in the present state of things, to determine; but it appears much more natural (when we consider its resemblance to *Erythrinus*, and of this latter to *Gonorynchus*) than to associate it with the herrings. The *Sudis gigas* (*fig. 55.*) is the largest

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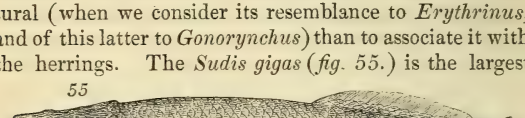

of four or five species which seem to be distributed in the fresh waters of America and of Africa. The typical form to which it shows the nearest approximation is clearly the anguilliform; and as we have no genus in the primary divisions of the *Salmonidæ* which represents those fishes, we confess that this consideration has materially influenced us in giving this station to *Sudis*. The scales are very large, strong, thick, and bony: the bones of the head are hard, naked, and rough: in some the muzzle is oblong, and in others shorter; while that of *S. gigas* is evidently depressed. In *S. Niloticus*, according to Ehrenberg, there is "a singular funnel spirally convoluted, which adheres to the third gill," which Cuvier, with much probability, conjectures is analogous to those which he has so ably and beautifully investigated in the genera *Anabas*, *Ophiocephalus*, &c. We have not yet come to our exposition of the spine-rayed order (*Acanthopteryges*), and therefore any partial exposition of its analogical characters would be premature; but if

the reader subsequently compares the circle of the *Salmonidæ* with that of the tribe *Macroleptes*, he will find that *Sudis* stands opposite to *Anabas* and the other labyrinthiform fishes, as their representative among the soft-rayed families, or the *Malacopteryges*. This analogy may, nevertheless, truly exist, and yet the precise situation of *Sudis* may be in some other circle; although, for the present, we believe it is really where we have placed it.

(230.) Such are what we consider as the three great aberrant divisions of the whole sub-family of the *Salmoninæ;* and we are now to see if they tally with those two whose types we have more particularly investigated, namely, the *Salmoninæ* and the *Characinæ*.

Primary Divisions of the SALMONIDÆ.	*Analogical Characters.*	Genera of SALMO.	Genera of CHARACINUS.
SALMONINÆ.	Mouth large; teeth strong, sharp.	*Salmo.*	*Serrasalmo.*
CHARACINÆ.	Mouth small; teeth often wanting.	*Coregonus.*	*Characinus.*
XIPHOSTOMA.	Mouth very large; teeth many, long, slender, unequal.	*Osmerus.*	*Cynodus.*
STERNOPTYX.	Mouth small, vertical.	*Anastomus.*	*Gasteropelicus.*
SUDIS.	Body lengthened, eel-shaped; ventral long.	*Mallotus.*	*Piabucus.*

(231.) Lastly, as it will tend much to strengthen our disposition of the *Salmonidæ*, we shall compare the five groups in which we have arranged them with the five principal divisions of the whole family; because, if the series in these are natural, they must possess some points of mutual resemblance.

Genera of the SALMON.	*Analogies.*	Sub-families of the SALMONIDÆ.
Salmo.	Typical of the	*Salmoninæ.*
Characinus.	Body and belly much compressed, the latter often serrated.	*Clupeinæ.*
Xiphostoma.	Muzzle depressed above; teeth numerous; dorsal fin placed nearest the tail.	*Esocinæ.*
Sternoptyx.	Mouth vertical.	*Mormyrinæ.*
Sudis.	?	*Cyprinæ.*

The circumstance of the European salmons being placed by all writers at the head of this family, as re-

presentatives of the whole, does away with the necessity of any further elucidation on this point. This view of the subject, however, is fully confirmed by the beautiful manner in which the salmon of America (*Characinus*) represent the herrings (*Clupeinæ*): both these groups have the body much compressed, more especially on the belly; and numerous examples in both occur of this part being not only sharp and carinated, but serrated like a saw: all the serrasalmos in one, and the saw-herrings in the other, answer to this description. We before remarked the similarity of *Xiphostoma* to the pike, not merely in its formidable teeth, but its depressed upper snout, and the backward position of its first dorsal; so that here, again, the analogy turns out to be strictly conformable to the natural series. We know so little of *Mormyrus*, that we are at a loss to discover in what respect it more immediately resembles *Sternoptyx*; certain, however, it is, that if the existing descriptions are correct, *Mormyrus* has the smallest mouth of any genus in the salmon group; and if we seek for this character in its highest state of development, we find it only in the chironectiform types, of which *Fistularia*, *Centriscus*, *Gomphosis*, &c. are notable examples: these genera, as will be seen hereafter, come in as the chironectiform types of their own groups, representing *Balistes*, &c. by their very small mouth, and *Chironectes* by its vertical direction. *Sudis*, in like manner, can only be assimilated to the carps through other groups. Having already endeavoured to prove that the *Cyprinæ* are the representatives of the eels among the salmons, we come also to the same conclusion respecting *Sudis*. The analogy of the first is shown by its food and habits, while that of the last is manifested by the lengthened form and general aspect. Fond as we are of tracing analogies, we cannot let them interfere with what appears to us natural affinities; and as we join with Cuvier in believing that *Sudis* is closely allied to *Erythrinus*, and that these, by means of *Gonorynchus* Gronov., pass into the *Cyprinæ*, —we cannot substitute any other type in the place of

Sudis, merely to give an additional air of perfection to the foregoing table. We now close our survey of the salmons, and proceed to the next family.

(232.) The CLUPEINÆ, or herrings, appear to hold a natural station between the salmons (*Salmoninæ*) and the pikes (*Esocinæ*). This situation has been assigned to them by the best ichthyologists, and thus we have the analogy strictly preserved in the circle of this class; for, upon comparing it with the spine-rayed fishes, we find the mackarel (*Scomberidæ*) come exactly parallel to the *Clupeinæ*, or herrings. In this very natural and strongly marked group, the adipose fin is entirely wanting, and the single dorsal is placed in the centre of the back, as in our new species, *Clupea aurovittata* (*fig.* 56.), which is as

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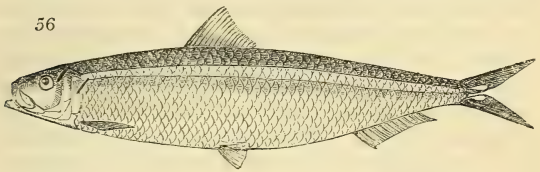

typical as the common herring. All the species are marine, and very seldom ascend rivers beyond the influence of the sea. The body is oblong oval, covered with large deciduous scales: the belly sharp, and generally serrated: the mouth, in its position, is mostly oblique, or inclining more to the vertical direction than to the horizontal; but it varies considerably in size, and in the armature of the jaws: the teeth, however, when they exist, are always small and slender. Cuvier remarks that the upper jaw is formed like that of the salmons,—in the middle by intermaxillaries without peduncles, and on the sides by the maxillaries. The opening of the gills is remarkably wide; and thus, as in all fishes so constructed, the herrings are known to die a few minutes after they have been taken out of the water. The bones of these fishes are more numerous and slender than of all others.

(233.) The natural history of the whole family, as far as known, bears a general resemblance to that of the

common species, among which the herring and the pilchard are the best known; but before we proceed to this subject, we shall first enumerate the chief divisions of this sub-family — numerous in species, but far less diversified in outward appearance than the last. We arrange the whole under the following genera, some of which contain minor divisions, or sub-genera: — 1. *Clupea*, or the true herrings, having the body compressed, the belly sharp and carinated, and often serrated; the dorsal fin in the middle of the back; and the mouth opening in an oblique direction: the caudal fin is always distinct from the anal, which, as in *Characinus*, is generally long. — 2. *Elops*, or salmon herrings, possessing the general form of the last; but the body is not compressed, nor is the belly either sharp or serrated: the mouth is moderate in size, furnished with teeth; and the anal fin shorter. — 3. The genus *Chirocentrus* differs materially from the two former, in the very backward position of the dorsal fin, which is almost as near the caudal as that of the true pikes. — 4. *Pristogaster* (*fig.* 57.), where the

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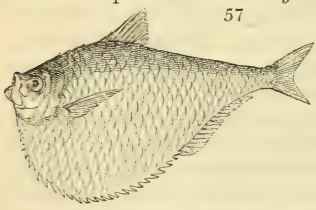

small mouth is completely vertical, and the belly curved outwards, is serrated as strongly as in any fish yet discovered: that this genus represents, in the most striking manner, *Sternoptyx*, *Gasteropelicus*, and *Anastomus* in the last family, is abundantly evident; and yet in many respects it seems so closely allied to some other kindred forms among the aberrant sub-genera of *Clupea*, that we have strong doubts whether it forms one of the *primary* types of this family; no other, however, that we know of, is a more perfect representation of the chironectiform type. — 5. Last of all, we place *Osteoglossum* of Vandell (*Ichnosoma* Spix) as the genus more immediately connecting this family with the last: it differs from all others by having the ventral, and some-

times almost the dorsal, united to the caudal fin : like all such fishes, the body is more or less lengthened and eel-shaped ; but its great compression, its large scales, and the general aspect, clearly show an affinity to the herrings ; while it also reminds us both of *Laurida* and *Esox*, by its numerous, slender, sharp, and unequal teeth.

(234.) The herrings, taken collectively, are moderate sized fishes, the greater number not exceeding in size that which is so well known on our own coasts ; yet a few others, found in tropical seas, attain to the gigantic length of from ten to twelve feet : many of them, however, are small ; and of these the sprat and white bait (*Clupea alba* Yarr.) are native examples. It appears that the whole of this family, so far as known, are carnivorous ; yet the animals upon which the greater part of them feed, are very small : we argue this from the excessive minuteness of the teeth, and even in the total absence of them in very many of the herrings ; and this idea is confirmed by the fact of immense quantities of minute shrimps, resembling our *sand fleas*, having been found in their stomachs : it seems, also, that they greedily devour the roe or spawn of other fishes ; since large quantities are said to be imported into France from the north of Europe, for the purpose of attracting pilchards to the nets.* There are several genera, however, whose teeth are much more developed, which, with their very wide mouths, leads to the conclusion that they feed upon other fishes and larger prey : among these are the anchovies (*Engraulis*), *Butirinus*, *Hyodon*, and particularly *Chirocentrus*, whose teeth, in fact, much more resemble those of the pike : the habits and economy, however, of all these are quite unknown. There is not much diversity among the herrings in the form and disposition of their fins : the dorsal is always single, at least in the more typical genera, and most generally placed towards the middle of the back ; this we make the strongest mark of discrimination between them and

* For this, and several other facts connected with the herrings, see Yarrell's *British Fishes*, — a work which abounds with similar interesting anecotes.

the pikes, where this fin is invariably inserted very near to the caudal: the pectoral is always pointed, and that of the tail (except in *Osteoglossum*) is uniformly forked: the ventrals are very small, sometimes obsolete, and rarely wanting; while the lateral line is either very close to the belly, or is not discernible. The unusual sharpness and rigidity of the belly in these fish, if the accounts of the mode in which they deposit their spawn can be relied upon, is easily explained: when the season for this operation commences, the herrings, abandoning their winter quarters, proceed in large troops to the breeding grounds; there they commence rubbing their belly against the ground, and, as if under great excitement, they rapidly vibrate their fins, agitate their bodies, and imbibe and reject the water through their gills with unusual vivacity. The food of the British herrings has been already noticed: those of Norway feed upon another species of minute crab, named by Otho Fabricius, from this circumstance, *Astacus harengum*. The number of these little creatures, during summer, is so near infinity, that in taking up a jug of sea water it will be often found to contain thousands. So partial are the herrings to these insects, that they follow them wherever they are driven by the currents or tides; and by feeding upon them continually, the belly of the fish acquires a tinge of red, occasioned, according to Strœm, by a reddish humour contained in these little creatures: that putrefaction proceeds more rapidly in such herrings as have been caught with their bodies thus filled, may be readily supposed, for the same takes place in all other animals; and it is well known to cooks, that the best method of keeping any animal for a long time fit for eating, is to clear out the contents of the stomach.

(235.) Recent investigations have gone far to prove the inaccuracy of those wonderful accounts, given by Pennant and others, on the migrations which the herrings and pilchards were supposed to make every year, from our own shores to the Arctic regions. The facts upon which this was founded seemed to favour the

supposition; but in this, as in many other cases, these very facts remain unimpeached, while they furnish directly opposite inferences. They do, indeed, only appear in immense shoals on our coasts at certain seasons, and, to all appearance, disappear as rapidly as they came; and yet it now appears that this migration is only from deep to shallow water, and that the herring, comparatively, is a domestic resident in our own seas. Numerous observations, too long to be here repeated, establish the fact, that the herrings inhabit the deep parts of all our coasts throughout the year; since individuals have been caught in every month. The great armies, however, of these fish, only come near the coast in summer, for the purpose of depositing their spawn; and here, as Mr. Couch so justly observes, we cannot but admire and praise the goodness of Divine Providence, by which these and many other fishes are brought to the shores, within reach of man, at that particular time when they are in their highest perfection, and therefore best fitted to be his food. On these occasions, the shoals may be compared to vast armies, led on by the largest and most vigorous, and followed by the rest, which are sometimes so numerous as to cover the sea for miles; so that, on entering confined bays of the shore, immense quantities have been stranded and crushed: these are followed and assailed on all sides by birds and hosts of ravenous fishes, such as the different species of sharks, porpoises, &c., who gorge upon their feeble unresisting prey; yet the numbers are so much beyond all calculation, that their ranks are never thinned. Large quantities are captured on our own coasts; but these are far exceeded by the fisheries of Sweden and Norway, where it is said that near 400,000,000 have been taken in one year, and 20,000,000 in a single fishery. Gothenburg, in Sweden, is celebrated for the great abundance of its herrings, of which there has been taken, in one year, the almost incredible number of 700,000,000. It is supposed that those taken to the northward of our own coasts are finer than those of the south; and hence

it is said that the fishermen of Scotland go out to meet the shoals as far as the Orkney and Shetland islands,—a useless labour, one would imagine, seeing that these very fish, in a few days, would reach the southern parts of Scotland.

(236.) The spawning is over, by those few, comparatively, who escape their numerous enemies, of which man is the chief, by the end of autumn; and this being accomplished, they again return to the depths of the ocean—or, at least, are no more seen, until the following year. Mr. Yarrell observes, however, that the young abound in shallow water, all round our shores in the summer months, and that they remain in the mouth of the Thames during their first autumn and winter. Perhaps the most conclusive evidence against the migratory habits of this fish, at least from the north, is furnished by the fact, that they visit the west coast of Cork in August, which is earlier than the arrival of those which come down the Irish Channel, and long *before* they appear at other places much further north. Mr. Wilson observes, that the herrings caught upon the east coast of Scotland are much inferior to those taken on the west coast, and more particularly to those of Loch Fine, and other lakes of Argyleshire. We were assured of this, also, by our friend, Robert Findlay, esq., of Glasgow, who further stated that they were caught at different periods of the year. A question naturally arises out of these facts,—May they not be of different species? "Dr. Knox states," continues Mr. Wilson, "that the herrings taken near the Firth of Forth are foul, or are engaged in spawning; while those of the west coast, in the same season, have the organs of reproduction very slightly developed *:" and he conjectures that the particular crustaceous animal which forms their favourite food, may exist abundantly in the bays of Western Scotland, but either not at all, or not in sufficient quantities, along the eastern coast. The time of spawning, according to Wilson (who is probably speaking of the Scotch herrings),

* Encyc. Brit. art. *Ichthyology*, p. 214.

"seems to vary considerably, both in the same and in different districts; so that we may have spring, summer, and autumn herrings, as we know they have in some parts of the Baltic."* We cannot believe, until the subject is completely investigated, that all these variations are met with in *one* species (*Clupea harengus, fig.* 58.),

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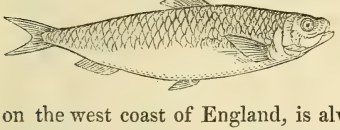

which is the same as the Cornish herring, whose time of spawning, and consequent appearance on the west coast of England, is always the same, however much they vary in the locality they choose, or in the comparative numbers in which they appear; in both these latter circumstances, but not in the former, they are proverbially capricious. The ancients do not appear to have known either the herring or the pilchard; although there is a species sometimes met with on the Sicilian coast so exactly like the latter, that even a professed ichthyologist may take it for the same (*fig.* 57.): as we only met with it on two or three occasions, and that in no abundance, in the fish-market of Palermo, we conclude it is not only rare, but does not live in shoals.

(237.) The pilchard is another fish of this family, and a much more important one to a large part of the population on our western coasts. According to Mr. Couch, whose valuable and most interesting history† furnishes us with much of the following account, the pilchard fishery, in the year 1827, employed, upon a fair average, no less than 10,521 persons; while the total amount of capital invested was calculated at 441,215*l.* Few persons, we imagine, would have any idea of such enormous amounts, seeing that this fishery is carried on in open boats, on a far less extensive scale than those for cod on the banks of Newfoundland, or for whales in the Arctic seas. Fishing, like all other things, upon which the results do not depend upon

* True; but there are, according to Mr. Yarrell, three species of herrings in the Baltic, and not one, as our author supposes.

† Inserted in Yarrell's Fishes, vol. ii. p. 96.

fixed laws, is hazardous and uncertain; and Mr. Couch, who resides upon the spot, appears to think, that, one year with the other, the greater part of the Cornish proprietors of the pilchard nets (or seins) obtain no more than their expenses; but when there is a profit, it is usually considerable; and thus every one hopes for a prize. The pilchard was supposed to migrate like the herring, but its range is now ascertained to be even more limited; it may be truly called a British fish, for it seldom wanders through the Straits of Dover in a northward direction, and its most southern range extends only to the coasts of France and Spain, where they are never found in any considerable numbers. It would seem to be found in Scotland, as Mr. Yarrell considers it the gipsy herring of that country; but he makes no mention of the localities in that kingdom where it has been captured. On the coast of Cornwall it seems to be found at all seasons: they sometimes congregate in immense numbers in March, and, in some years, thousands of hogsheads have been taken at that season; but it is only in July that they regularly unite permanent in society for the rest of the year: it is then that the regular fishery commences, and it is continued until the equinoctial gales of autumn render its further prosecution impracticable. When thus united near the coast, observes Mr. Couch, the pilchards assume the arrangement of a mighty army, with its wings stretching parallel to the land; the whole being composed of numberless smaller bodies, which are alternately joining the main body, shifting their position, and again separating. There are three chief stations to which they resort, and which have a separate influence on the success of the fishery: one is to the eastward of the Lizard Point; the second is between this and the Land's End; and the third is on the north coast of Cornwall, towards St. Ives. It is no uncommon circumstance for one of these districts to be full of fish, while no shoal is to be met with in the others. It was formerly the custom to station men on such elevated situations near the sea as

would enable them to see the course of the pilchards, and direct the fishermen, by concerted signals, how best to surround them; but this custom now only exists, as Mr. Couch affirms, at St. Ives.

(238.) The fishery is carried on in common fishing boats, with four men and a boy, who commence their operations a little before sunset; and the nets are drawn in about two hours, to be again shot, or laid, as morning approaches. The number of fish thus taken in a night's fishing, by these drift boats, is, of course, uncertain; from 5000 to 10,000 is considered moderate, but double this number are often captured; while 150,000 fish for one boat during the season is reckoned favourable. There is another method employed, called sein-fishing, to prosecute which three boats are provided: two of these are each provided with a sein, or net; while the other is merely used for the purposes of enabling the head fisherman (or master seiner) to be rowed about, and make observations. These three boats proceed in the afternoon to some sandy bay, where they cast anchor, and watch for the fish. The presence of the pilchards is discovered either by the peculiar rippling of the water, the colour it assumes, or by the leaping of the fish themselves a little above the surface. So soon as they are discovered, the head fisherman proceeds to ascertain the size of the shoal, and the direction it is taking: this done, the greatest activity is immediately used to throw the nets in a line across the course of the fish,—an operation which, notwithstanding the size of these nets, is generally performed, from long practice, in less than five minutes: the crew of the two larger boats are then employed in warping the ends together, while those in the third boat, which is behind, by dashing and beating the water, frighten the fish away from that part only where they could turn round and escape. Whether the shoal be large or small, the trouble is thus the same. The net is then closed, and the ends laced together: if the fish are numerous, and the sea or tide strong, the whole is secured by grapnels; and when the evening has closed

in, and the tide is low, they proceed to empty the nets. The fish soon become so exceedingly agitated, and so great is the accumulated force of their numbers, that, if it has been a full haul, the utmost caution is necessary lest the nets should burst or sink. When brought to the surface, the voices of the men are lost in the noise made by the fish in struggling to escape, and in dashing the water. They are taken out in buckets (or flaskets), and only in sufficient quantities to load the boats: the rest of the fish are left in the net until the first are salted; another cargo is then taken out: and thus a week may possibly elapse before the whole of the capture is secured; part being taken out every night. Nearly the whole of the pilchards thus procured and salted are exported to catholic countries, but chiefly to those of the Mediterranean, where we have often eaten them. The numerous fasts of the Romish church cause an immense consumption of fish, both fresh and salted, all the year round. This appears still more striking, when it is remembered that, besides the extensive fisheries of the *Sardi* (a small species of *Clupea*) and of the tunny, which the Italians themselves carry on, and pickle, they require immense quantities of stock-fish or cod from Newfoundland; and all these independently of the pilchards of Cornwall, the greater part of which are sent to them. The quantities of these are so immense, that, to prevent our being suspected of exaggeration, we shall cite Mr. Couch's own words. "The quantity of pilchards taken is sometimes incredibly large. A fisherman, now alive, was once present at the taking of 2200 hogsheads of pilchards in one sein; but the greatest number heard of, as taken at one time, is stated by Borlace at 3000 hogsheads. Each was formerly calculated as containing 3500; it was then changed to 3000, and is now 2500 fine fish; but it is scarcely necessary to say they are not counted.* An instance has been known,

* "In reference to this anecdote, Pennant has made an astounding error, in reckoning, by mistake, 35,000 fish to a hogshead, instead of 3500. The hogsheads, probably, are made of such a uniform size, as to contain this exact number, — few more or less."—*Yarrell.*

when 10,000 hogsheads have been taken on shore in one port in a single day; thus providing the enormous multitude of 25,000,000 of living creatures drawn at once from the ocean for human subsistence."

(239.) We shall now enter into the detail of this interesting group, — interesting from the importance it possesses in an economic point of view, and doubly so to the ichthyologist, because it is one of the most perfect circular groups which we shall have to lay before our readers. On this account, and from the analysis we have been enabled to make of the whole, we shall not merely enumerate the sub-genera, but trace, in the principal or typical group, the series of those links by which these latter types are united. The primary divisions already enumerated, we consider as genera; the lesser ones, consequently, we view, with Cuvier, as sub-genera. We commence with *Clupea*, under which we place all those herrings that have the teeth either minute or altogether wanting; the body is also much compressed, the belly sharp or serrated, and the dorsal fin placed in the middle of the back. By these characters we distinguish the true herrings from the salmon-herrings, — a name we apply to those whose teeth are very conspicuous; for although the aberrant forms of *Megalops* have the body or belly serrated, as in all of the sub-genera of *Clupea*, yet the former have well-defined teeth, which are not perceptible in the latter, except, indeed, in *Thryssa*, or that sub-genus which connects the two groups. The position, also, of the dorsal and anal fins, hitherto so little regarded that no notice whatsoever has been taken of them, separates *Clupea* from *Chirocentrus*, &c.; so that the group becomes very definite.

(240.) Commencing with the herrings of Britain, as the true type of the genus, we observe the dorsal fin lunated, and placed nearly in the middle of the back; while the ventral fin (little inferior to the pectoral) is directly under it: the anal, in comparison to

the other types, is rather short, so as not to exceed the length of the dorsal. All these characters are possessed by the shads, which have merely a slight emargination on the upper jaw,—a variation so slight, when compared to numerous others in this group, that we cannot possibly adopt the sub-genus *Alosa**, or rather *Clupanodon;* for the latter name has the priority of the former by many years. From these to *Chatoessus* the transition is very gradual: the change consists in the prolongation of the terminal ray of the dorsal, which exceeds the others so much as to become twice or thrice their length. These fish are generally much broader than the herrings, as in *C. thryssa*†: the relative size and position of the dorsal and ventral fins are the same as in *Clupea;* but the anal fin is considerably longer, and the mouth usually much smaller. They are all natives of warm seas, chiefly of India. In two or three, a remarkable deviation from the usual equality of the jaws is observable: the snout or point of the upper jaw projects beyond the under,—a deviation of structure which can only be explained when we look to the singular herrings forming the sub-genus *Thryssa;* this group is a very remarkable one on many accounts. In the first place it has an obvious alliance to the anchovies, upon which account Cuvier has placed them following each other,—a station which we shall subsequently show is truly natural: this affinity is indicated by an excessively wide mouth; the edges of the jaws, particularly the upper, or maxillaries, being sometimes armed with a single row of short, isolated, acute teeth: these, however, must not be considered as a primary character, because they are sometimes wanting; while in other species, as *Thryssa Hamiltonii* Gray‡, they appear distinctly defined; the tip of the snout, also, is sometimes, as in the last species, rather advanced over that of the lower jaw, similar to what we see in the anchovies, while in others

* If such deviations of structure are sufficient for sub-genera, that of *Thryssa* alone might furnish five or six of equal value.

† Bloch, pl. 404. ‡ Ind. Zool. vol. ii. pl. 92. fig. 3.

the mouth is nearly as vertical as in *Pristogaster*. Now the question is, How can these deviations of structure be explained? and what affinities do they indicate? The advanced snout of *Chatoessus nasus* and *latus*, seems to prepare us for the same structure in some of the *Thryssæ*, while the more vertical mouth of the typical species of *Thryssa* plainly intimates, we conceive, that the next type which follows in the series is *Pristogaster*. The circumstance, again, of some of the *Thryssæ* having teeth, and others none, is at once accounted for, when we recollect that it is through this group we pass from the toothless herrings, or *Clupea*, to the salmon-herrings, or *Elops*. This variation, therefore, must consequently happen, because it is precisely in this part of the series that the teeth began to appear. Cuvier has simply observed of *Thryssa*, that it only differs from the anchovies with serrated bellies by the greater prolongation of their maxillaries. This is such an indefinite character, that we have placed all the serrated anchovies in *Thryssa*, leaving only such as have the belly smooth (like the European) in *Engraulis*. *Thryssa* is further distinguished from *Clupea* and *Chatoessus* by the position of the ventral fins: these, instead of being placed under the dorsal, are situated *before* it, and are so small as only to be half the size of the pectorals; thus, again, we are prepared for *Pristogaster*, where these fins totally disappear: the mouth is still more vertical, or, rather, it is completely so; while the dorsal fin, which is very short in *Thryssa*, is now so much reduced, as, in one instance, to be totally wanting.* The Indian species of *Pristogaster* are oblong or lengthened fish, while those of the Atlantic are short and broad: these latter, we suspect, are the true types; since the deep, prominent, and arched belly, which is the chief character of these fishes, is more developed in the American than in the Indian species: the mouth, as just observed, is completely vertical; and this, with its small size, and its

* *Apterygia*, Gray, Ind. Zool.

toothless jaws, separates *Pristogaster* both from *Thryssa* and *Engraulis*. The absence of teeth, again, indicates a return to the typical form of *Clupea*. But there is yet another modification of form which is necessary to effect this union. This is seen in certain herrings which have all the characters of *Pristogaster*, except that they have a remarkably small ventral fin — so small, indeed, that it may be considered rudimentary: to these we give the name of *Platygaster*. In some, as in *P. verticalis**, the mouth is completely vertical; in others it is less so (*P. Africana*†); while in some, which approach the true herrings, the mouth (as in them) is only oblique. As the progress of this transition from *Pristogaster* to *Clupea*, through *Platygaster*, is not only particularly beautiful, but highly important to our present purpose, we shall call the attention of ichthyologists to the steps by which it is effected; for it fortunately happens that this can be done by the aid of the figures of such species as have already been published. In the first place, let the reader turn to the 192d plate of Russell's *Indian Fishes*, where he will find, at fig. 2., our *Pristogaster elongata* (*Tardoore* Russ.), a fish which Cuvier himself cites as one of the types. Now the figure immediately above this (*Platygaster verticalis* Sw.) is absolutely a *Pristogaster* in its form, its vertical mouth, and its long anal fin; while it is a *Platygaster* in its very small ventral fin, placed a little before the dorsal: the position, also, of this latter fin is more towards the middle of the back than in *Pristogaster elongata;* and thus it agrees with *Clupea*. The very same structure is seen in *Platygaster macropthalma* Sw.‡ We then, in *P. affinis*§, get the typical structure; the minute ventral fin being nearer to the pectoral than to the dorsal, and the mouth less vertical than in the two former species. *Platygaster Africana*‖ leads us a step nearer to *Clupea*, the ventrals being rather nearer to the line of the dorsal than to the pectoral. This

* Russell, pl. 192.
† *Clupea Africana*, Bloch, 407.
‡ *Iangarloo*, Russell, pl. 191.
§ *Clupea affinis*, Gray, Ind. Zool.
‖ *Clupea Africana*, Bl. pl. 407.

fish brings us at once to *Clupea*, by that singular species, the *Clupea Sinensis* of Bloch, which is a true herring, having, however, the same broad form as *P. Africana:* the ventral, although placed beneath the dorsal, is yet very small, being only half the size of the pectoral; while the anal, although not so long as in that fish, is yet longer than in any other example of the typical *Clupeæ*. Here, then, all further distinction ceases, for we actually return to the first type we began with: the circle of the series is closed; and we find *Clupea*, *Chatoessus*, *Thryssus*, *Pristogaster*, and *Platygaster* so closely and intimately blending into each other, that we scarcely can say where one begins, or where the other ends.

(241.) Affinity, more especially when so strongly manifested as in these instances, must always take place of analogy. We have, therefore, laid before the naturalist these details, before we premised any thing of the results or inferences that may be drawn from them; let him go through the series himself, and then, if we are not greatly deceived, he will be fully sensible of its representative nature, and will hardly need the following confirmation of it, drawn from the analogies which this group presents to all the others we have given of this family: those, however, of the principal divisions of the *Clupeinæ* are so conclusive, that we cannot refrain from drawing them up.

Analogies of the SUB-GENERA *to the* GENERA *of* CLUPEINÆ.

Sub-genera of CLUPÆ.	*Analogies.*	Genera of CLUPEINÆ.
Clupea.	The pre-eminent type of dorsal fin lunate.	CLUPEA.
Chatoessus.	Dorsal fin prolonged into a filament behind.	ELOPS.
Thryssus.	Mouth oblique, excessively large; teeth sharp.	OSTEOGLOSSUM.
Pristogaster.	Mouth small, completely vertical; ventral fins none.	ODONTOGNATHUS.
Platygaster.	Ventral fins exceedingly small; anal fins long.	CHIROCENTRUS.

We know not which of these two expositions are most

in accordance with all we have said on the nature and properties of natural groups, — the close affinities between each of the types in the first column, or the beautiful analogies which they find in the primary divisions of the *Clupeinæ*. We here deal, in the first instance, with facts, and facts only; — the inferences are an after consideration; but they are just as strong, to any mind which understands the nature of inductive reasoning, as the facts themselves; and to those who do *not* comprehend the Baconian philosophy, all argument is useless. Addressing ourselves, therefore, to the former, how singularly does *Thryssus* and *Osteoglossum* represent each other by their enormously wide mouth — cleft in an oblique direction, and armed with single detached teeth: this structure, with the slight projection of the muzzle, immediately reminds us of the sharks and the pikes, which these fishes, as being representatives of the cartilaginous type, so singularly represent, as well as *Xiphostoma*, and numerous others. The completely vertical mouth of *Pristogaster*, with the entire absence of the ventrals, reminds us immediately of *Chironectes* by the first character, and of *Balistes* by the second; while, if we look for a repetition of these forms under a different modification among the salmons, we are at once presented with *Sternoptyx*, more especially resembling the American *Pristogaster Martii* of Spix. The disappearance of the ventrals, and the great development of the anal fins, no less than the superior length of the tail (or, what is the same thing, the proximity of the vent to the pectorals), is a very general character among the apodal fishes; and one or both of these characters are also seen in *Platygaster* and *Chirocentrus*; although, as the latter, by the backward position of its dorsal, passes into the pikes, it assimilates even more to that group than to *Platygaster*. We had almost forgotten to notice the wonderful resemblance between *Chatoessus* and *Megalops*,—a resemblance so strong to a superficial eye, that none but an ichthyologist would detect their absolute difference: both have the elongated form of the

herring, joined to the prolongation of the last ray of the dorsal into a filament; yet in *Megalops* the mouth is strongly armed with teeth, and the belly is neither compressed nor carinated; while in *Clupea* the jaws are all but toothless, and the ridge of the belly is sharp and serrated. *Clupea*, in its most typical examples, represents, of course, the whole group; so that, whatever minor divisions may, and possibly do, enter into this circle, the prominent variations intimately correspond (so far as the nature of the group will admit) with all that has been said of the primary types of ichthyology, or, rather, when these views are extended, of those of the whole vertebrated circle.

(242.) Leaving the toothless herrings, we come now to those which have well-defined and often numerous teeth; the majority of which, also, are without the sharp serrated belly which pervades the whole of the last division. We look upon the Linnæan genus *Elops* as exhibiting the most typical structure of this group, associating with it *Butirinus*, as a subordinate form: following these we place *Megalops*, *Notopterus*, *Trichosoma*, and *Engraulis*, all of which are at once known by possessing determinate or well-defined teeth.* There is not sufficient information on these fishes to allow of our tracing the series so effectually as in the last; but M. Cuvier places them close together †, and we shall now proceed to show how intimately they are all allied. The reader will remember that the genus *Thryssa* was the only one of the last group which had a wide mouth and distinct teeth; and that it consequently opened a passage from *Chatoessus* to the true anchovies. *Engraulis*, therefore, will be the first type of our present division after leaving *Clupea:* we restrict this sub-genus to those anchovies of which the common Mediterranean species

* This must remain questionable in regard to our new genus *Trichosoma*, the *Engraulis Hamiltonii* of Gray, Ind. Zool., because, as no description of this fish has been published, we can judge only from the figure; but as Mr. Gray associates it with the anchovies, we may presume that its teeth are the same.

† Cuvier's series is as follows: — *Notopterus*, *Engraulis*, *Thryssa*, *Megalops*, *Elops*, and *Butirinus*.

is the type, and thus confine it to such as have the belly not serrated: possessing much of the general form of *Thryssa,* these small fishes are nevertheless much more slender; the cleft or commissure of the mouth is more horizontal; the top of the muzzle more projecting over the mouth; and the jaws or maxillaries, as Cuvier well remarks, less prolonged: the anal fin, which is long in *Thryssa,* is shorter in *Engraulis.* M. Cuvier alludes to an anchovy found in America, his *E. edentatus,* which is without any teeth: we have not seen this; but as it would appear to have a serrated belly, we should place it as an aberrant *Thryssa,* forming another link in the chain of those species which unite the toothed *Thryssæ* with the toothless *Chatoessi.* Leaving this sub-genus, we pass on to *Elops* and *Butirinus,* because M. Cuvier observes of the latter, that "the muzzle is prominent like the anchovies:" both, however, differ from those fish, in the mouth being smaller. On looking to the figure of *Elops saurus* (Bloch, 393. f. 1.), the ichthyologist will be fully persuaded that its affinity is with *Engraulis,* and that its analogy is with *Clupea:* its rather wide mouth, opening horizontally; the great prolongation of the maxillaries, which reach far beyond the eye; and the distinct teeth, establish the first of these relations: while the size and position of the ventral fin, as well as the shortness of the anal, render this fish so like a true herring, that if the snout was concealed, and the belly serrated, it would pass for such. Of Commerson's genus *Butirinus,* which we have not seen, Cuvier intimates that it has all the characters of *Elops,* except in having "the muzzle prominent, the mouth but slightly cleft, and the tongue, vomer, and palatines paved with rounded teeth set close together." Now, as there must be aberrant species between the types of *Engraulis* and *Elops,* we look upon these fishes, at present, as being such; but it will still remain a question which of these is the true type, or, rather, which is subordinate to the other: the form of the jaws in *Butirinus* would certainly lead us to place it next to the anchovies, while

the elongated lower jaw of *Elops saurus* opens a passage to the sub-genus *Megalops:* in this we still have the rounded belly of the last fishes; but from them, and all others of the toothed herrings, they may at once be distinguished, on account of their possessing a dorsal fin shaped exactly like that of *Chatoessus*—that is, with the last ray prolonged into a filament: all the species have conspicuous teeth, close and even upon their jaws; and some also have them on the palatines: the gill membranes, as in *Elops*, has a great number of rays, but these vary among the species; while in some the last ray of the anal corresponds to that of the dorsal, in being also prolonged into a filament: this deviation is particularly seen in an immense species found in America, which sometimes grows to the length of twelve feet. Other species occur in the Atlantic; and Dr. Russell has figured some from India. The next type in our series is that of *Notopterus* Lac., founded upon a rare Indian freshwater fish, considered by Pallas as a *Gymnotus**, but removed by Cuvier to this family. Never having seen a specimen, we must take for granted that the great ichthyologist of France is correct in this view of its affinities; and, judging from the figures that have been published, we join in the same opinion. The general aspect of this fish is that of a herring; but it differs from the three preceding types of this division by having the carinated edge of the belly serrated, the ventrals remarkably small, and the anal long, narrow, and united to the caudal fin: this latter character we have not hitherto noticed in the whole of this family, and for subsequent reasons it deserves great attention: not only the jaws, but the palatines and the tongue, are all armed with teeth; those on the two former are fine, but those upon the tongue are strong and hooked. In most of the toothed herrings, the number of the branchial rays are remarkably numerous; but in this, according to Cuvier, there is but one, which is strong and osseous. We have now enumerated four of the types, and we

* Pallas, Spec. Zool. vol. vi. pl. vi. fig. 2. Bontius, Ind. p. 78.

want a fifth to enable us to return again to the anchovies, with which we began our survey. We should suppose, from theory, that such a type should present us with some of the characters of *Notopterus*, joined to others which would be more characteristic of *Engraulis*, and these so combined as to present a structure altogether peculiar: this, we repeat, would be our theoretical notion of such a type; but is it only theoretic, or is there, in reality, such a fish? This question we can now positively answer in the affirmative: the *Engr. Hamiltonii* of Mr. Gray (*fig.* 59.) has precisely that union of characters

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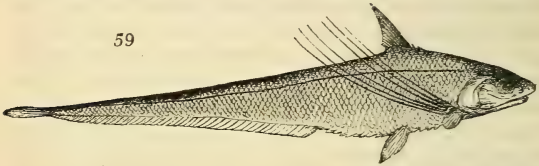

which we have described; and although there is nothing as yet to guide us but the figure*, we cannot but be struck with the belief that it represents a form intermediate between *Engraulis* and *Notopterus*: it has the head of the former, the snout being considerably advanced beyond the lower jaw; while it has the long anal fin of the latter, and this fin, moreover, is so united to the caudal, that, like *Notopterus*, it might have very well been arranged, by the old authors, among the *Gymnoti*. Its other characters are still more remarkable, and renders it the most extraordinary fish in the entire family of *Clupeidæ*. We have had, in fact, some hesitation in placing it here, under a suspicion that, instead of being a secondary form, as we now arrange it, among the toothed herrings (*Elops*), it was, in reality, one of the primary types of the whole sub-family. Nevertheless, it has been our rule, in all such cases, to be guided in the first instance by what appears the greatest affinity; and under the impression that *Trichosoma* is more connected to *Engraulis* than to any other of the herrings, we

* Gray, Ind. Zool. vol. i. pl. 85. fig. 3., here reduced.

follow Mr. Gray in approximating it to them. The preceding cut (*fig. 59.*), which is a reduction of the figure alluded to, will show this affinity, and will supersede a more particular description of its form, &c. The remarkable fascicle of long, slender, and detached filaments, inserted close to the pectoral fin, is altogether unexampled in this family, or, indeed, in the entire order of *Malacopteryges*, and yet we have precisely the same structure in *Polynemus*: in both the genera these filaments may, perhaps, be analogous to the digitated processes in the gurnards (*Triglidæ*): the smallness of the pectoral fin is another anomalous character, of which we are unacquainted with any other example; while the length and attenuated form of the tail would almost lead us to consider this fish as an anguilliform type: still the similarity it bears to *Engraulis* and to *Notopterus*, as we at first mentioned, cannot be got over; and, influenced by these relations, we decide upon placing *Trichosoma* as the representation of *Polynemus* among the herrings. This adherence to what we deem an affinity, will not altogether destroy the analogy of the sub-genera of *Clupea* to those of *Elops*, as the following table will show:—

CLUPEA. Teeth minute or wanting.	*Analogies.*	ELOPS. Teeth conspicuous.
1. *Clupea.*	Dorsal fin with the upper margin simply lunate.	*Elops.*
2. *Chatoessus.*	Dorsal fin with the last ray prolonged into a filament.	*Megalops.*
3. *Thryssa.*	Teeth variable; mouth very large; snout slightly produced.	*Engraulis.*
4. *Pristogaster.*	Belly strongly serrated; anal fin very long, almost or quite united to the caudal.	*Trichosoma.*
5. *Platygaster.*	Ventral fins almost imperceptible.	*Notopterus.*

We have already said sufficient on the analogies of *Clupea* to *Elops*, *Chatoessus* to *Megalops*, and *Thryssa* to *Engraulis*, to render any further remarks unnecessary. These analogies are indeed so obvious, that it would be a waste of words to bring forward additional evidence.

The same, however, cannot be said of the resemblances between *Pristogaster* and *Trichosoma:* the horizontal mouth of the latter is directly opposed to the vertical one of the former; while the ventral fin, which is altogether wanting in *Pristogaster,* is actually of a larger proportionate size in *Trichosoma* than in any other type of the whole family with which we are acquainted. The analogy, therefore, if such it be, between these two types, must, at the best, be looked upon as remote — we may almost add questionable. We could get over this difficulty, it is true, by substituting *Odontognathus* for *Trichosoma,* because that type is an unquestionable representative of *Pristogaster;* but this would, as we conceive, be sacrificing affinity to analogy; or, in other words, would be separating *Trichosoma* from those fishes to which it has every appearance of being truly allied, merely for the purpose of perfecting our analogical table. Another consideration has much influence on our mind in this decision, which, as it tends to illustrate a very important character in *Trichosoma,* we shall now lay before our readers. The character to which we allude, lies in the long filaments near the pectoral, which we cannot but suspect are really analogous to those processes among the *Triglidæ,* or gurnards. Now, it will be subsequently shown that the whole of these genera compose the *most* aberrant type of the acanthopterygious, or spine-rayed, order of fishes — analogous, in fact, to the situation we have here assigned to *Trichosoma:* to render this more apparent to the reader, we shall here place the two groups in juxtaposition, for the sole purpose of showing that, when so placed, these two points turn out to be parallel with each other.

Macroleptes.		Elops.
Microleptes.		Megalops.
Gymnetes.		Notopterus.
Canthileptes.	(Triglidæ, &c.)	Trichosoma.
Blennides.		Engraulis.

As any attempt to explain the whole of these presumed analogies would lead us from our more immediate

purpose, and would, in fact, be anticipating our future exposition of the order *Acanthopteryges,* we shall pass them over, and at once proceed to the other groups of the *Clupeinæ.*

(243.) We have now disposed of the two most typical groups of the family before us, and shall proceed to the other three, which we consider are aberrant. We commence with *Osteoglossum*, because it follows that of the toothed herrings, represented by *Elops* and *Megalops.* The annexed cut (*fig.* 60.) of this singular type (*O. bicir-*

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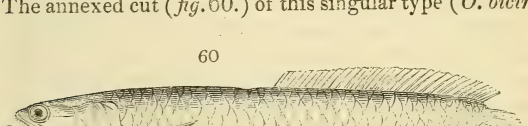

rhosum Sw.*) will give an accurate idea of its genera structure. In the continuity of the dorsal, caudal, and ana fins, as well as its lengthened tail, it reminds us of the eels; while its large oblique mouth, and very short muzzle, present some resemblance both to *Laurida* and *Thryssa:* the teeth, however, although numerous and sharp, are not very unequal in their length. Cuvier remarks of this type, that it has many relations with *Sudis;* but he has not stated what these relations are, and to us they appear few and very remote;—the one is nearly cylindrical, the other much compressed; and their general physiognomy is very different. There is no fish, yet discovered, where the scales, in proportion to the size of the body, are so enormously large as in this type; and Spix mentions that they are very hard. Cuvier remarks that the tongue is osseous, and singularly rough, from a multitude of short, straight, and truncated teeth, with which it is covered; so that, as he conjectures, it serves like a rasp to reduce fruits to a pulp, or to express their

* *Ichnosoma bicirrhosum* of Spix, pl. 25.

juices: upon what authority, however, this is made a frugivorous fish does not appear, and the supposition seems to us highly improbable. The great size of the pectorals, when compared with the ventrals, is worthy observation; as also the interruption (if it really is so in nature) between the dorsal and the caudal: this we have preserved in the figure, which is reduced from that given by Spix; but we suspect that in a perfect state this interval is filled up so as to render all the three fins continuous.

(244.) The next genus which we place as aberrant, is *Odontognathus*, arranged by Cuvier close to *Pristogaster:* that there is some sort of relation between the two is very obvious; but whether this is of strong analogy or absolute affinity we do not know. The only figure existing of this strange-looking fish is that of Lacepede's, which Cuvier says has been taken from a badly preserved specimen: this we can readily believe, since the maxillaries are represented as assuming the appearance of two porrect horns in front of the mouth, —a structure which no fish can possibly have; and yet the size and form of these maxillaries appear to be so different from those of *Pristogaster*, that we are induced to think the resemblance is only analogical,—the more so, as these maxillaries are stated to be "armed with small teeth directed forward," of which no instance is known to exist in *Pristogaster*, where the mouth is very small, and the teeth altogether wanting. The mouth must be completely vertical; the anal fin is almost united to the caudal; and the dorsal is so small and brittle as to be "almost always obliterated." Only one species is known, which is rather small, much compressed, and comes from Cayenne. In the third and last aberrant division we place two sub-genera, *Chirocentrus* Cuv. and *Hyodon:* these, although somewhat different from each other, may be immediately distinguished from all the other types of this family by their numerous teeth, but more particularly by the very backward position of the dorsal fin, which is almost as near the caudal as in

the pikes: it is, in short, by these genera that we conceive the sub-families of the *Clupeinæ* and the *Esocinæ* are united; they are herrings in their shape and general aspect, but pike in the position of their dorsals, and almost in the armature of their mouth. *Chirocentrus* is represented by some few fishes found in the East Indies: one of these is particularly described and figured by Russell, under the name of *Wallah* (*Chirocentrus Russellii* Sw.). According to this author, it has a long knife-like body, which is entirely destitute of scales; the mouth is large, very oblique, and with the lower jaw longest; in the upper jaw are four long, projecting, lanceolate teeth, with many small marginal ones behind; in the under jaw they are long, distant, and reflected; the tongue is small, ovate, and smooth*; the palate is also smooth: in others the tongue, according to Cuvier, is "bristled with pectiniform teeth." The body of both these is much lengthened; the belly sharp, but not serrated; the dorsal close to the caudal; and the ventrals extremely small.

(245.) The genus *Hyodon* (*H. clodalis* Le Sueur, *fig.* 61.)

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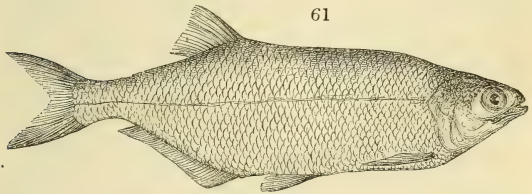


approximates to the last by having the dorsal situated towards the caudal; but the form is more like that of the

* Cuvier cites this very description of Russell's *Wallah* for the "single species that is known" of this type; the teeth of which he describes as follows: "The intermaxillaries and maxillaries are both furnished, as well as the lower jaw, with a range of strong conical teeth; two of which, in the middle of the upper range, and all below, are of extraordinary length: the tongue and branchial arches are bristled with pectiniform teeth." It is clearly impossible that this can be the species described by Russell, which has the "tongue smooth." It is more than probable, also, that the other synonyms of Cuvier refer to different species, and that several, in short, exist in the Indian seas. It is such variations as these, in the teeth of fishes, which show how often they are merely specific — not generic — characters.

ordinary herrings; and Cuvier, while he places it next to *Chirocentrus*, assimilates it to the salmon-trout, by the "hooked teeth on the jaws, the vomer, the palatines, and the tongue." The best account of these curious fishes, however, will be found in Le Sueur's own words. The hyodons, as he observes, "inhabit the river Ohio and the lake Erie, where they go under the popular name of herrings. They have, in effect," continues our author, "much resemblance to *Clupeæ* in their colour, their large eyes and scales, and the compressed form of their body,—and with which genus they may be confounded on a superficial view: but it is easy to distinguish them by the absence of the carinated abdomen; by their extremely short intermaxillaries and maxillaries, which are articulated together; and by every part of the mouth being strongly toothed, as in the salmon family of Cuvier. They have in a great measure the habits of these last; as, like them, they appear to prey upon living animals, particularly insects, which they take on the surface of the water. The stomachs of several of these fishes, which were examined, were filled in the spring with *Scarabæi* and the larva of *Ephemera;* the perfect insects of the latter, at that period, being observed, in immense multitudes, swarming over the surface of the Ohio. The want of an adipose fin in our fishes," concludes this excellent zoologist, "excludes them from the genus *Salmo:* by their teeth they seem to approximate to the genera *Chirocentrus* and *Erythrinus* of Cuvier and Gronovius, and the *Amia* of Lacepede: but they differ from the first by the vomer being furnished with teeth; from the second, also, by the teeth; and from the third by the pectorals, the dorsal, the teeth, the gill-covers, &c." He then describes two species with great accuracy, *H. tergisus,* and *clodalis* (*fig.* 61.). For the present we follow Le Sueur and Cuvier in associating this genus with *Chirocentrus,* not from any conviction that their resemblance is one of affinity, but, until the *Salmones* are better understood, and the sub-genera naturally arranged, we think it preferable not to make any

further innovations on the existing dispositions of these groups. We have a strong conviction, however, that *Hyodon* will hereafter be brought in among the aberrant types of the *Salmoninæ*, with which, in every thing but its single dorsal fin, it bears, both externally and internally, the strongest resemblance, — a resemblance which extends to its habits, food, and the fresh waters to which both are more especially appropriated. If we ventured a conjecture upon its true station, we should place it between *Osteoglossum* and *Xiphostoma*. The absence or presence of an adipose fin is considered the sole distinction between the *Cyprinæ* and the *Salmoninæ*, and between the latter and the *Clupeinæ* — and it is, doubtless, one of the most typical characters that we yet know of; but at the confines of each of these groups we must look for considerable variation in this respect, because every naturalist is fully aware that when nature is about to quit one type of form, she modifies her structures in such a way that many of the strongest characters she had been employing are lost, and are exchanged for others which only exist in their full perfection in the next group to which she is advancing. Besides this, we have several instances of two closely allied genera, in which one has two dorsal fins, and the other only one. The most striking of these that at present occurs to our mind is in the case of *Loricaria* and *Hypostoma* among the *Siluridæ*, — two types which Cuvier places only as sub-genera, although the latter has an adipose fin, while the former has none. We have before expressed our suspicion that some of the sub-genera of Brazilian salmon, as *Prochilodus* Agass., and even *Anodus*, may eventually be found to enter among the carps; and for the above reasons *Hyodon* would not be absolutely excluded from forming an aberrant group among the salmons, merely because it has not an adipose fin. However this may be, we feel perfectly satisfied on the situation we assign to *Chirocentrus*, whose whole structure is intermediate between the herrings and the pikes.

(246.) Having now closed our survey of the entire

family or sub-family of *Clupeinæ*, we shall just advert to the analogies which seem to result from the disposition we have made of the various groups, by instituting a comparison between the

Analogies of the CLUPEINÆ *and the* SALMONIDÆ.

Primary Types of the HERRINGS.	*Analogies.*	Primary Types of the SALMONS.
Clupea.	Body much compressed; mouth small, obliquely vertical; body sharp and serrated.	*Characinus*, or *Serrasalmo.*
Elops.	Mouth larger, more horizontal; belly (typically) smooth; body not much compressed.	*Salmo.*
Osteoglossum.	Mouth excessively large; teeth strong, numerous; head compressed.	*Xiphostoma.*
Odontognathus (?).	Mouth completely vertical; no anal fins.	*Sternoptyx.*
Chirocentrus.	Dorsal fin close to the caudal.	*Sudis* (?).

The reader will remember that we have considered Lacepede's genus *Serrasalmo* as one of the typical representatives of the American salmons; and it is interesting to see how much they accord with that of *Clupea:* both have the body greatly compressed, and much broader than any of their congeners; both have the mouth small and obliquely vertical—at least such is the direction of the lower portion of the jaws in *Serrasalmo;* and both have the very unusual character of the belly being sharp and serrated. In *Elops* and *Salmo*, on the other hand, the form of the body is more lengthened; the belly is neither sharp nor serrated; the mouth is cleft almost horizontally; and the very aspect of the two groups show an intimate resemblance. This, indeed, cannot be said of the external form of *Osteoglossum* and *Xiphostoma;* and yet there are points which intimate a similarity of structure, and, consequently, of habits: each has the largest mouth in its own circle; the teeth in both are slender, unequal, and numerous: but the truth is, that each contains very few species; so that, as there are no very aberrant examples, there are no intermediate links of connection. We before remarked, that Cuvier intimates a resemblance between *Osteoglossum* and *Sudis;* and we

at first imagined this was analogical, because both have the dorsal and anal fins very close to the caudal, and some of these fins, in *Osteoglossum*, are actually united; but then the great breadth and depression of the head in *Sudis* is so directly opposed to the narrowness and compression of this part in *Osteoglossum*, that we incline more at present to assimilate the latter to *Xiphostoma*, and the former to *Chirocentrus*. The question, however, may be left open to discussion, because, at present, *Sudis* is such an isolated form, notwithstanding its general similarity to *Erythrinus*, that its other affinities remain uncertain. The analogy of *Odontognathus* to *Sternoptyx* is more satisfactory; and will equally hold good, whether it be ultimately retained as a primary type of the *Clupeinæ*, or as one subordinate to *Pristogaster*. These three last analogies, it must be remembered, regard aberrant types; and such types are always more varied—more disconnected, as it were, among themselves — and therefore more difficult to determine by a graduating series of connecting species, than either typical or subtypical groups, wherein the intermediate modifications of form are always more numerous.

(247.) The Esocinæ, or pikes, succeed the herrings: they constitute, in our present arrangement, a subfamily; and although, in point of numbers, they appear much more restricted than either of the three families we have already disposed of, the variations in their structure are so remarkable, and the gradations between them so few, that their natural arrangement is proportionably as difficult, and an artificial one is easy. Where the line of continuity is lost or not discovered, the different forms will appear isolated, and will then furnish the most positive characters; but when these forms are modified in a variety of ways, so as to present ramifications of different relations, we have some clue to the natural series. The most prevalent character of all the fishes that have been classed among the pikes, is that of the dorsal fin being placed very far backward, so as to be close to the caudal; while the anal fin is immediately below it. The unusual

disposition of these fins influences that of the others: the ventrals are thus placed in the middle of the body, or about half way between the pectoral and the caudal: the latter is always forked; and the former, in general, pointed. The whole of these fishes are excessively voracious and destructive to others: hence Lacepede has justly said of the common pike, that it is the shark of our ponds and rivers. We accordingly find the mouth to be particularly large, the snout often greatly lengthened, and the teeth, in nearly all instances, numerous and sharp. There is no instance of a second dorsal or adipose fin, as in the salmons; or of the belly being sharp or serrated, as in the herrings. As to other parts of their structure, it may be mentioned that the margin or edge of the upper jaw is formed by the intermaxillary bones; or, at least, when this is not the case, the maxillaries are without teeth, and partially concealed. Excepting the common pike, and a few others nearly allied to it, the whole of the remainder are marine fishes.

(248.) We have already said that the connecting links between the different genera placed by authors in this group, are very few: nevertheless, by the help of these, and of the mode of variation more clearly to be traced in the other divisions, we may arrive at more definite notions as to the probable cause of the natural series than would at first be expected. We have already seen in *Chirocentrus*, the last genus among the herrings, that the fins are placed almost precisely in the same situations as those of the pikes, although the sharp belly and other characters assimilate those fishes to the *Clupeinæ*. Now this link in the chain is most important; since it not only determines the connection between these two sub-families, but also guides us, in some measure, to look for that group among the pikes which shows the nearest affinity to the *Clupeinæ*. Cuvier appears to have had no hesitation in arranging the *Exoceti*, or flying fish, with the *Esocinæ*, close to those long-snouted genera which comprehend the gar-fish. There can be no doubt, however, that the true types of the whole

of this sub-family are the fishes represented by the *Esox belone* of Linnæus, — a rank which they derive from their exact analogy to the *Xiphianæ*, or sword-fish, in the corresponding circle of the acanthopterygious order; and therefore, correctly speaking, the family name of *Esox* should have been retained to this most typical group. It is one of the beauties of the system of representation, that the typical forms of an extensive circle, in cases of this sort, may always be determined by the simple and sure method which nature has herself taken of pointing out her own analogies. The name of *Esox*, however, being, by long usage, so universally affixed to the freshwater pikes, we shall so retain it, distinguishing the gar-fish by that of *Ramphistoma*, long ago given them by Rafinesque. Following these three genera we shall place those of *Stomia* and *Chauliodes*, whose obtuse mouth we have been in some measure prepared for by *Esox*. In regard to the fifth or last type, much uncertainty prevails: the genus *Diplopterus* of Mr. Gray may possibly be the true one; and yet the great elongation of the jaws in *Lepisosteus*, and its depressed muzzle, seems to bring it much nearer to the gar-fish and the pikes than to any others of this order. Cuvier, indeed, places it at the end of the soft-rayed families, intermediate between *Osteoglossum* and *Polypterus*, but without venturing to intimate any supposed affinity with either; and it is plain that he places these three together, not as having any real connection, but as being in some measure related to the groups that precede them. If such an accomplished ichthyologist, with all the materials of the French Museum at his command, could not determine the natural station of this singular genus, we may well be pardoned for being equally unsuccessful.

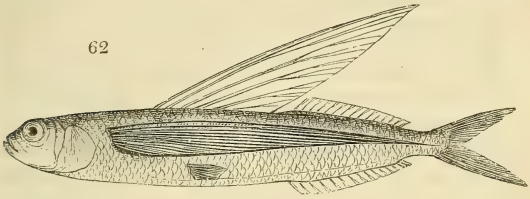
(249.) These extraordinary creatures, the flying fish, forming the genus *Exocetus* Linn., will first be noticed, both as to their habits and their classification. By Linnæus they were placed much nearer to the herrings than they have been by Cuvier, who arranges them in a

different family, close to the gar-fish (*Ramphistoma* * Raf.). That they have an intimate relation to both of these groups, is very obvious; but it is not so easy to determine to which they naturally belong. If we regarded their sharp carinated body, their small obliquely cleft mouth, the peculiar form of the maxillaries, the smallness or total absence of the teeth, and even their large deciduous scales, we should at once place them among the herrings; while, if we attach more importance to the backward position of the dorsal fin, and the singular carinated lateral line placed close to and on each side of the belly, we should adopt Cuvier's idea of arranging them close to *Hemiramphus*,—more especially as the preponderance of characters are certainly in favour of these fishes belonging to *Esocinæ*, but at that extreme point where they pass into the herrings. Some very important analogies, also, will result from this arrangement, which, as it was made by Cuvier, becomes totally uninfluenced by such considerations. As *Chirocentrus* was the last type among the herrings, so does *Exocetus* become the first among the pikes: from the absence of intermediate or graduating forms, the connection is not very obvious; and yet, when we look to the profile of their heads, the depression of the crown, the sub-vertical direction of the mouth, the sharpness of their belly, and the position of their dorsal, anal, and ventral fins, we see a manifest relation between them; although in one the teeth are highly developed, while in the other they are almost or altogether wanting.

(250.) The *Exoceti*, or flying fish (*Exoc. evolans* Linn., *fig.* 62.), however, are chiefly remarkable for the enormous development of their pectoral fins, by the aid of which they are sustained in the air during a short time—when they have more the appearance of birds than of fish; so that if

* *Esox belone* Linn. The impropriety of calling this group by such a name as *belone*, need not be pointed out. M. Cuvier's names are in general so well chosen, and so classically constructed, that we always feel repugnance in proposing to substitute others for the very few which are faulty. In the present case, however, as in that of *Laurida*, M. Cuvier's names have not even the claim of priority, for *Ramphistoma* was proposed seven years before that of *Belone*.

we have birds which swim, these are fishes which fly. A great deal more has been said and written on this interest-

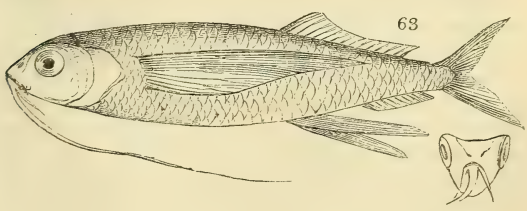


ing subject than it would be necessary to repeat, but for the purpose of rectifying error ; and having had numerous opportunities of witnessing these fishes in their native seas, what we shall now state will be the result of personal observation. It has been said, indeed, that the name of *flying fish*, given to this group, is an error, because they only leap into the air, where they have not the power of sustaining themselves at will; but this is a mere quibble. An animal which can make its way in the air, in the general acceptation of the word, certainly flies, although that flight is not sustained by the motion of the members, and ceases when there is no longer power for continuing the exertion. The idea that this power ceases when the membrane which connects the pectoral rays is dry, is very possible, but we do not think it can be determined as a fact. Thirty seconds is the longest time absolutely mentioned for these fishes to be out of the water*; and although we never precisely ascertained this, we do not think that the time is understated. Now, as the atmosphere under the equinoctial line, where these fishes most abound, is almost always excessively damp and moist, it is highly improbable that the membrane of their fins would dry so very rapidly as in half a minute after they have been saturated, as it were, with sea water, immediately on the rising of the fish. It is said, also, that the fins are merely used a

* Bennett's Wanderings, vol. ii. p. 30.

parachutes, and do not, as in birds, propel the fish forward by repeated motion: this, again, admits of doubt: the flight of these fishes, although short, is very rapid,—almost as much so as that of a swallow; and every one knows that these birds will go over a good extent of ground with little or no beating motion of the wings. In crossing the line, in the year 1816, we were very anxious to ascertain this point in the economy of the flying fish; but although we had them before our eyes almost every quarter of an hour for a week, their flight was so rapid, that, at the nearest distance they ever were to the ship, we found it as utterly impossible for the eye to determine this question, as it is to see the vibration of the wings of a fly. Our impression is, that this act of flying is effected in two ways: first, there is a spring or leap, by which the fish is raised out of the water; and then, that the pectoral fins are spread, and are employed to propel the fish in a forward direction, either by a few flappings, or by that motion which is analogous to the skimming of swallows. That this could not be continued when the moisture of the fins began to be absorbed, is quite obvious; but we think that it is only discontinued until the fish suppose themselves to be out of danger. It is quite true that they have not the power of elevating themselves in the air in an undulating direction, as we see in swallows, — the course of their flight being always that of a very slight arch, the height of which, we believe, varies with the species. We have frequently seen great variation in the height which flying fishes ascend: those towards the equinox of America have a low flight; so that, although innumerable flocks rose round our vessel in all directions, not one ascended sufficiently high to fall into it. On the other hand, it has been mentioned, that they have fallen into ships which were from fourteen to twenty feet above the water: it may be as well to observe, that this could only have originated in the flying fish having been impeded in their course over the vessel by the ropes or other tackle; because their return to the water is always

very gradual, so that the last ten or fifteen yards of their course is almost parallel with the waves. It is seldom that more than 200 or 300 rise up at once, so that it is an exaggeration to magnify this number to thousands. Neither do they fly in all possible directions; for their flight, with very little variation, is always straight forward, and they only diverge a little to the right and left when they are about to re-enter their more natural element. Sometimes, indeed, they fly off in an obliquely angular direction from that which they at first took. This is an important fact, because it proves that this flying is not merely effected by a leap, but by the action of the fins and tail, just as these members are used to influence the course of birds: the forked structure of the caudal fin has an obvious connection with this power, but in what manner the pectorals are used we are altogether ignorant. We have no doubt that more than double the number of species of *Exocetus* really exist above those that have been described; and we have to lament the loss of three, at least, that formed part of our Brazilian collection: those of India, the Mediterranean, and the Pacific, are probably all different. Some of these, forming our genus *Cypsilurus*, are singularly characterised by the possession of simple or lobed cirri or barbels proceeding from the lower jaw. We here insert the cut of one of these (*C. appendiculatus, fig.* 63.), described by Wood* as inhabiting the American seas.



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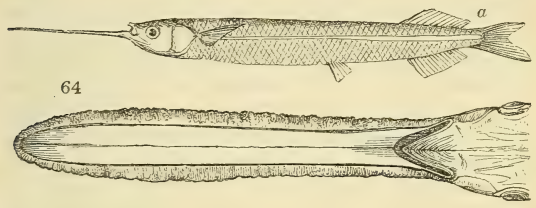
* Journal of the Acad. of Nat. Sciences of Philadelphia, which for brevity we cite as Amer. Trans. vol. iv. p. 283.

(251.) The genus *Ramphistoma*, or gar-fish, have but a very slight connection, so far as their external form is concerned, with the flying fish; and yet there are some points of anatomical coincidence, which, in the absence of intermediate forms, bring them together. They are long, narrow, and compressed fishes, at once known by the excessive prolongation of their jaws, which in this respect are precisely analogous to those of the sword-fish (*Xiphinæ*), which represent them, in fact, in the opposite circle of the acanthopterygious or spine-rayed fishes. Although not a numerous group, the gar-fish appear to contain three or four sub-genera,—two of which, *Ramphistoma*, properly so called, and *Scomberesox*, occur on the British coast. The first of these is the *Esox belone* of Linnæus,—a fish very often seen in the London markets in the spring, and remarkable for the beautiful green colour of its bones: it seldom exceeds two feet long. No ichthyologist seems yet to have been successful in ascertaining the precise nature of its food, although there can be no doubt, from the structure of the teeth, that it devours small fish. Mr. Couch, who has observed its habits, informs us*, that "it swims near the surface at all distances from land, and is not unfrequently seen to spring out of its element; its vivacity being such that it will for a long time play about a floating straw, and leap over it many times in succession. When it has taken the hook, it mounts to the surface, often before the fisherman has felt the bite; and there, with its slender body half out of water, it struggles, with the most violent contortions, to escape: when newly taken it emits a strong smell." The gar-fish seem widely dispersed, for they occur in the Atlantic and in Tropical India; but we found no species in the Mediterranean. Of the sub-genus *Scomberesox*, also, only one species is British: it chiefly differs from the last in having the hinder portion of the dorsal and anal fins divided into those finlets which are so conspicuous

* Yarrell's Fishes, vol. i. p. 392.

among the mackerel. The sub-genus *Hemiramphus* Cuv. is another subordinate type of this genus; and its singular mouth is perfectly unique among fishes: the lower jaw is of the same proportionate length as in the gar-fish, but the upper is so short that it appears as if broken off almost at its base. It would be highly interesting to know those particular habits which require a structure of mouth so different from all other fishes; but this remains unknown. Various species are found in the tropics of both hemispheres: one of these, the *Hem. Brasiliensis?* (*fig.* 64.), we have examined in a fresh



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state, and thus been able to detect a singular peculiarity, not yet noticed. On both sides of the lower jaw (which, in its depressed shape, resembles the upper one of a saw-fish deprived of its spines) is a thin membranaceous fringe or skin, very delicate, and which is half the breadth of the jaw itself: it is quite clear that this jaw is not used either to secure the food upon which this fish may feed, for the point of it is quite obtuse; neither can it be employed to thrust into the sand or other substances, for then this membrane would be destroyed immediately: besides, the circumstance of the other gar-fish swimming close to the surface of the water, shows that their food is not found at the bottom; and this also must be the case with *Hemiramphus*, whose shape and general structure, in every thing but its mouth, is perfectly the same as *Ramphistoma*. Now it is a remarkable circumstance, that we have a genus of birds,

equally unique in its own class, where the mouth is similarly constructed: in *Rhyncops*, or the skimming terns, the upper jaw, in fact, is considerably shorter than the lower; and these birds skim along the surface of the sea to feed upon those minute animals, which are only to be found there: this well-authenticated fact, which we have elsewhere enlarged upon, throws considerable light upon the probable habits of these fishes, which every induction of reason leads us to believe habitually feeds much in the same manner, and on the same description of animals — that is, on such as float upon, or swim very near to, the surface.

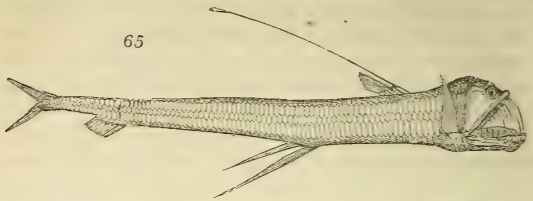
(252.) Quitting the gar-fish for the present, we pass to the fluviatile pikes, to which belongs the well-known fish of that name (*Esox lucius* Linn.), so common in our lakes and ponds. The boldness and voracity of this fish is proverbial; it not only gorges itself with all others that it can swallow, but attacks other animals, as if from mere savageness, or as if, accustomed to overcome and devour every other fish that it was in the habit of encountering, it had lost the instinct of discrimination. Mr. Yarrell has collected several remarkable instances in proof of this, to which we must refer the reader. It has been known not only to seize ducks, water hens (*Fulica*), and other aquatic birds, but even to make unprovoked attacks upon man, and retain its hold with all that pertinacity which would seem as if it could conquer and devour a being ten or twenty times larger than itself. There is a story, often repeated, told by Gesner, that a pike was once caught at Heilbrun, in Germany, which had a brass ring attached to it, intimating that it was put into the lake in the year 1230; so that, being captured in 1497, it must have been 267 years old. One would have been incredulous on this subject, but Gesner further asserts that the skeleton, nineteen feet in length, was long preserved at Manheim as a great curiosity. It would be well worth the trouble of inquiry, of any fragments of this gigantic monster are

yet in existence, or if any records regarding it exist at that place: for ourselves, we confess our entire disbelief that such a pike, and of such an age, ever existed. The largest, we believe, that has ever been captured in this country, was the famous one caught by colonel Thornton in one of the Scotch lakes, which measured exactly four feet four inches from eye to fork: the colonel says, that on opening his jaws, "so dreadful a forest of teeth, or tusks, I think I never beheld." The shape of the pike is much more like that of an ordinary fish than of the *Ramphistomæ:* the snout and jaws, indeed, are rather lengthened, but they are blunt, depressed, and large; upon opening the mouth, which is very wide, it appears to be absolutely lined with teeth of all sizes, covering the jaws, palate, and vomer, or throat: the size and depression of the head must be particularly noticed, since it far exceeds that of any other fish in this order, and will be subsequently adverted to. It is fortunate for other fishes, that there are very few species of pikes; and the wonder really is, how any others can live in the same waters with such a depopulating monster. It has been ascertained that eight pikes, of about five pounds' weight each, consumed near 800 gudgeons in three weeks.

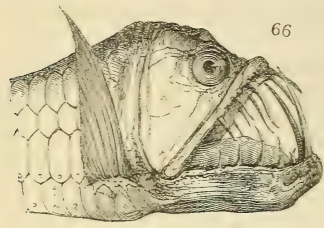
(253.) The genus *Leptodes** is the next form among the pikes to which we assign a primary rank. Very little has been published of this extraordinary fish, and it would appear that even Cuvier himself had never seen it; while the only figure existing is the rude and ill-drawn one of Catesby, which has been copied repeatedly into other works. Among the numerous fishes we collected in the Mediterranean was one of these; but it has shared the fate of nearly all the others, and seems to be no longer in existence. Fortunately, however, a coloured drawing was made from the fresh specimen, which is reduced

* The name of *Chauliodus*, given to this type by Schneider, is particularly expressive, but unfortunately it had long been used to designate an equally remarkable genus of neuropterous insects by Latreille; so that we have no other alternative than to propose another — *Leptodes*

in the annexed cut (*fig.* 65.); and the head is also repre-

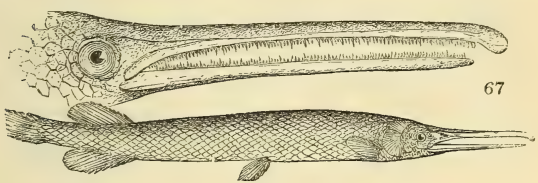


sented, but of the natural size (*fig.* 66.). These figures will convey to the reader a much better idea of this extraordinary creature than any detailed description. The head, but more especially the mouth and teeth, are enormously disproportionate to the size of body; and, indeed, the latter members are larger than in any other fish yet discovered. There seems also sufficient difference between the species known to Catesby, and the Mediterranean one now figured, to justify us in believing they are different species: the absence of a terminal spoon-shaped membrane at the tip of the first dorsal ray in the former may be accidental; but this cannot be said of the difference in the size and proportion of their scales, or the shape of the caudal fin, which is lunate in *L. Sloanii*, but cleft to the centre of the base in *L. Siculus* (*fig.* 65.): in the latter, also, the dorsal fin is inserted much nearer to the pectoral than it is to the ventral; but in *Sloanii* it is just intermediate between the two. These fishes are very rare, and are only seen, like *Sternoptyx*, *Gymnetrus*, and other strange-looking genera, after violent storms, which have agitated the bottom of the sea, and cast these delicate fishes upon the beach. In the course of five years we never met with more than



two individuals lying dead upon the Isthmus of Messina. The sub-genus *Stomias* is evidently of this type, but differs from it in having the dorsal fin situated as in all the other pikes. Risso describes two species inhabiting the Mediterranean, neither of which we had the good fortune to meet with.

(254.) The last genus which we bring within the confines of this family is *Lepisosteus** Lac. (*fig.* 67.) There



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can hardly be any doubt that this remarkable fish belongs to the pikes, although Cuvier, with singular infelicity of arrangement, places it immediately after *Osteoglossum*. The only question seems to be as to its more immediate allies, and the rank we should assign to it. In its form, and in the disposition of its fins, it immediately reminds us of the gar-fish; but then the body, which is nearly cylindrical, is entirely covered with diamond-shaped scales as hard as stone: the edges, or outer rays, of all the fins are defended with spine-like scales, quite analogous to the spined fins of the *Siluridæ*, while the muzzle, although long, is broad and depressed: both jaws are internally covered with numerous rasp-like teeth, with a row of larger ones intermixed, and placed at their edges. There is no gar-fish yet discovered having any thing like this structure, and we therefore view *Lepisosteus* as a primary rather than as a secondary type among the *Esocinæ*. Rafinesque shortly describes several species as inhabit-

* The figure given by Lacepede, and copied in the *Ency. Brit.* pl. 305. fig. 4. is entirely erroneous; for it is, by some strange mistake, turned upside down, so that the pectoral and ventral fins seem to be a second and third dorsal fins: that of Bloch, pl. 390., is a tolerably good representation.

ing the fresh waters of America * ; but as no figures of them have been published, or no specimens have reached England, we know, as yet, very little about them.

(255.) The other genera or sub-genera placed by authors in this family, will be noticed in the systematic part; and now, having selected what appear to be the most prominent types of form, we will place these together, and ascertain what analogous resemblances to them can be found in other groups. In the first instance, we shall compare the whole of the tribe or family of *Salmonidæ* with the circle (subsequently to be made out) of the *Scomberidæ*, in order to show the relation of the pikes to the sword-fish.

Sub-families of the *Salmonidæ*.	*Analogies.*	Types of the SCOMBERIDÆ.
SALMONINÆ.	Mouth large; teeth strong; belly not compressed.	*Thymnus.*
CLUPEINÆ.	Mouth and teeth small; belly compressed.	*Scomber.*
ESOCINÆ.	Mouth large; jaws excessively developed, one or both being very long and pointed.	*Xiphias.*
MORMYRINÆ.	Mouth very small; muzzle greatly lengthened.	*Fistularia.*
CYPRINÆ.	?	*Lepidosaurus* (?).

At present we must confine ourselves to one of these analogies, or that between the pikes and the sword-fish, than which nothing can be stronger. The analogy of *Mormyrus* to *Fistularia*, both with their long snouts, yet little mouths, is also sufficiently evident; and there is a remote resemblance between the two first groups: the relation, however, to the two latter we cannot make out, but this point will be returned to hereafter.

(256.) We shall next compare the foregoing divisions of the *Esocinæ* with the malacopterygious families; chiefly with a view of showing that *Lepisosteus* is the representation of the *Siluridæ* in its own family.

* *Ichthyologia Ohiensis*, or Nat. Hist. of the Fishes inhabiting the River Ohio and its Tributary Streams. Lexington, 1820.

Circle of the *Malacopteryges*.	*Analogies*.	Types of the ESOCINÆ.
SALMONIDÆ.	Typical.	*Ramphistoma*.
PLEURONECTIDÆ.	Sub-typical.	*Esox*.
GADIDÆ.	Dorsal fin placed close to the head; mouth very large.	*Leptodes*.
SILURIDÆ.	Snout depressed; body covered with osseous plates or scales; fins with spines on the first ray.	*Lepisosteus* (?).
COBITIDÆ.	Mouth very small.	*Exocetus*.

We thus find *Lepisosteus* to be among the pikes, what *Loricaria* is among the silures; because, as the latter genus is pre-eminently typical, it of course stands as the representative of its own family. We must remember, also, that *Lepisosteus* is the only pike, or, indeed, the only genus yet discovered in the whole of the *Salmonidæ*, that has the first ray of the fins spinous; and this peculiarity of structure makes them representations also of the cheloniform fishes, or the *Plectognathes*—the types of which, as in the *Balistidæ*, have the first dorsal ray almost always armed with prickles.

(257.) Lastly, we may compare the divisions of the pikes with those of the herrings; for although the analogies, in one respect, cannot be made out, the others are very observable.

Genera of the PIKES.	*Analogies*.	Genera of the HERRINGS.
Ramphistoma.	Body considerably compressed; teeth minute or none.	*Clupea*.
Esox.	Body rounded; teeth strong.	*Elops*.
Leptodes.	Mouth excessively large, and oblique.	*Osteoglossum*.
Lepisosteus.	?	*Pristogaster*.
Exocetus.	Belly compressed; dorsal fin near the caudal.	*Chirocentrus*.

It is the total absence of all resemblance between *Lepisosteus* and *Pristogaster* which makes us believe that the former enters as a sub-genus among the gar-fish, or the *Ramphistomæ*, and that the real type between *Exocetus* and *Leptodes* has either not been discovered, or is unknown to us. This, however, has not the least effect

in destroying the claim of *Lepisosteus* to be a tenuirostral type, or that which, in ichthyology, is to represent the primary order of *Plectognathes;* for whether it be placed with the gar-fish, or stand by itself, as we have for the present arranged it, it becomes the most aberrant in either group, and thus possesses all the analogies we have more especially pointed out. There is a little fish, indeed, published by Mr. Gray under the name of *Diplopterus pulcher* (*fig.* 68.), which, from the position of its

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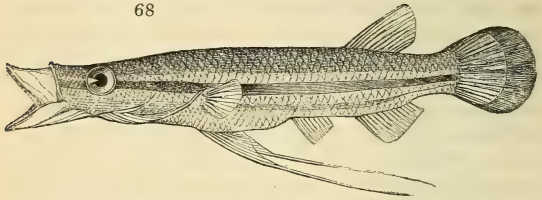

dorsal and anal fins, seems to enter among the *Esocinæ;* but no description having been given of it, we are fearful of hazarding any conjecture on its affinities, seeing that the facts upon which that could be done are insufficient. We deem it best, however, to mention it in this place, in the hopes of directing the attention of ichthyologists to the subject.

(258.) On the last division of this extensive family, which we have named the *Mormyrinæ* (*Mor. elongatus* Rüpp., *fig.* 69.), we can say but little. The fishes we in-

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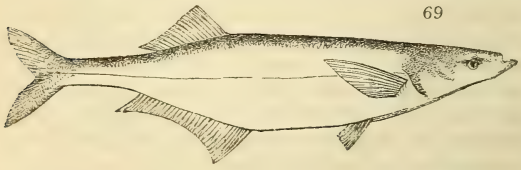
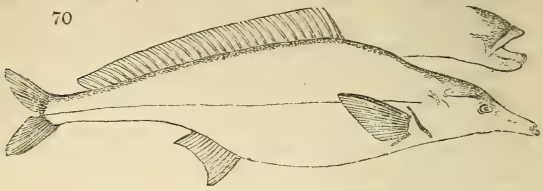


clude under this denomination form the Linnæan genus *Mormyrus*, which has been also preserved entire by all

writers. That this group is related to the *Esocinæ*, and yet has a claim to be considered perfectly distinct, is admitted by Cuvier, who places them at the end of the pikes; observing that "they will very probably give occasion to form a particular family." That they are also related to the *Cyprinæ*, or carps, may be inferred from Linnæus having named one of the species *M. Cyprinoïdes*. Both these opinions are reconciled by the situation we now assign them, as an intermediate or connecting group between these two sub-families. The whole of the species are confined to the fresh waters of Tropical Africa, chiefly those of the Nile and the Senegal; so that, never having seen them in a fresh state, and but in a cursory way in museums, we shall give M. Cuvier's description of their structure nearly in his own words. These, he observes, are fishes with a compressed, oblong, scaly body: the tail is slender at the base, and enlarged towards the caudal fin: the head is covered with a naked and thick skin, which envelopes the opercula and the rays of the gills; so that the aperture is merely a vertical cleft, the branchial rays being five or six: the aperture of their mouth is very small, almost like that of the ant-eaters; and the angles are formed by the maxillary bones: some slender teeth, with their tips emarginate, are on the intermaxillaries and the lower jaw; while there is a long band of other teeth, small, and crowded, upon the tongue and under the vomer: the stomach is like a rounded sack, followed by two cæca; and there is a long and slender intestine almost always enveloped in much fat. Among these fishes, thus generally characterised, there appear several remarkable variations. The most singular are those which have the muzzle long and cylindrical (*Scrophicephalus longipinnis* Sw., *fig.* 70.); but among these some have the dorsal fin short, while in others it is lengthened. Another sub-division has the muzzle short and rounded; while in a fourth there is a gibbous projection on the upper part of the muzzle, which extends beyond the mouth. The resemblance which the long-snouted or typical species bear

to the genus *Centriscus* is so great, that Schneider has actually called one of them *Centriscus Niloticus;* so that



this resemblance being admitted, and the situation of the whole group intimated by the authorities we have cited, we may feel some degree of confidence in the station now assigned to these fishes. The resemblance of the *Mormyrinæ* to *Centriscus, Fistularia, Syngnathus, Gomphosis,* and all other long-snouted fishes, is too obvious to be expatiated upon; while no question can remain that this resemblance is one of analogy, and not of affinity, since Cuvier and most other ichthyologists agree in placing *Mormyrus* close to the pikes and carps. Whether the singular genus *Diplopterus* Gray enters among these, or forms a part of the *Esocinæ*, is an interesting but an inferior question: we are now dealing with large assemblages; and if these are once determined, the more minute details and relations can be subsequently worked out.

CHAP. X.

ON THE PLEURONECTIDÆ, OR FLAT FISH, AND THE GADIDÆ, OR CODS.

(259.) The Pleuronectidæ, or flat fish, succeed the salmon family. Although the greater part are savoury and even delicate eating, it must be confessed that they are most unsightly fish, totally devoid of that graceful

form and symmetrical colour which belong, more or less, to nearly all others of this class of animals. The form of the flat fish is so well known to every one, from the frequency of their being served up at our tables, that there is no occasion to enter on a tedious description. The genera, comparatively, are very few; and when we have seen a plaice and a sole, we have seen the two most dissimilar forms yet discovered in the whole family. On a cursory view, it appears as if the body of these fish was flattened in the same way as that of the skates, but this is only an analogical resemblance; that of the *Pleuronectidæ* is compressed vertically, while that of the *Raidæ*, or skates, is depressed horizontally: this distinction should always be kept in mind when we are comparing the repesentations of these fishes in other families; for many of the *Chætodonidæ* (which are the flat fish of the spine-rayed order of *Acanthopteryges*) are just as much compressed, and some (as *Psettus* Cuv.) even more than the *Pleuronectidæ;* but then the position of the eyes, both being placed on one side of the head, renders their distinctions very obvious. It is impossible, in fact, to conceive a more beautiful union of analogical characters than are to be found in this singular-shaped group. Placed as one of the types of the order *Malacopteryges*, the *Pleuronectidæ* should bear a relation both to the *Chætodonidæ*, or chætodons, on one side, and to the *Raidæ*, or rays, on the other: this they accordingly do, by having the body excessively high and compressed, the fins partially covered with scales, and the rays semi-spinous: on the other hand, they show a marked resemblance to the *Raidæ* in having both the eyes placed on one and *the same* surface of their bodies, and in one of these surfaces being of a different colour from the other. These two characters, throughout the whole class, are solely possessed by the *Raidæ* and the *Pleuronectidæ;* and these analogies not only corroborate the correctness of the situation we have assigned to each of these groups, but are borne out by the similarity of the habits of the *Raidæ* and the *Pleuronectidæ*, in laying

flat upon the bottom of the sea, waiting in ambush for their prey.

(260.) The flat fish, besides the peculiarity in the situation of their eyes, have some other characters of a unique nature. The two sides of the mouth are not symmetrical; and sometimes one of the pectorals is only half the size of the other; and this inequality extends to the bones of the cranium, but which, according to Cuvier, are the same, in other respects, as in ordinary fishes. The general sameness in the external structure of these fishes renders it very difficult, if not impossible, to make out the principal types; and therefore, as the technical definitions of the genera will be given in the synopsis, we shall here confine ourselves to a few general remarks on the whole family.

(261.) The geographic distribution of these fishes is in almost all temperate and tropical seas; but they seem to diminish towards high northern and southern latitudes. They are abundant with us, and very common in the Mediterranean. The largest species, we believe, that has yet been discovered, is the holibut (*Hippoglossus vulgaris* Cuv.), which is often seen suspended in the fishmongers' shops in London. On the coast of Norway this fish often attains the weight of 500lb., and Mr. Yarrell mentions one that was taken near the Isle of Man and sent to Edinburgh in 1828, which measured 7ft. 6in. in length, and weighed 320lb. We know too little of the foreign flat fish to say whether other species attain to this size, but those on the Brazilian coast are of the ordinary dimensions; and the holibut is, we believe, unknown in the Mediterranean. The turbot, as an edible fish, is the most celebrated of all the numerous species of the Atlantic. We cannot, however, coincide in the belief that this delicious fish was known to the Athenians; for although the *Pleuronectidæ*, as a whole, are common in the Grecian and Sicilian seas, we never saw the turbot there, nor ever heard of its being captured. A great deal of interesting information on the fishery of this article of luxury has been given in Mr. Yarrell's

volumes, which the reader would do well to consult. The manners of all these fish, as well as of the soles, appear to be much the same. They keep close to the bottoms, generally choosing such as are sandy; here, partially covered by the surrounding sand or soil, which, by the peculiar shape and construction of their fins, they are enabled to throw about them, these fishes lie in ambush, watching for any prey which may come within range of a sudden dart: at other times, however, these sedentary habits are laid aside, and they shift their hunting grounds, often in large shoals, when one sort of food is exhausted, and another is sought for. Mr. Yarrell observes, no doubt from good authority, if not his own, that, when near the ground, the plaice (*Platessa vulgaris* Cuv.) swim slowly, maintaining their horizontal position; but, when suddenly disturbed, they sometimes make a rapid shoot — changing their position from horizontal to vertical: if the observer happens to be opposite the white side, they may be seen to pass with the rapidity and flash of a meteor; but they soon sink down, resuming their previous motionless horizontal position, and are then not distinguished any more than the rest of the family, owing to their great similarity in colour to the surface on which they rest. The food of the flat fish is exclusively of an animal nature; but as their mouth is of moderate size, and their teeth small, the things they feed upon are of proportionate dimensions: young fish and crabs, small and soft molluscous and radiated animals, are what are generally found in their stomachs.

(262.) The resemblance between the colours of the flat fish, in general, to those of the ground they repose upon, is so admirably ordered, as to claim both attention and admiration. The upper surface, or that which is exposed to view and to the action of the light, is invariably of some shade of earthen brown, or of greyish sand colour; this is broken by dots and blotches, either light or dark, blackish or reddish, but always so disposed as perfectly to resemble those under-shades, as they may be called, which are caused by the inequalities of the

ground and the presence of particles of different tints that may be upon it. Thus, whether we contemplate the God of Nature in his most sublime productions, or in those provisions which He makes for the well-being of his most irrational creatures, the same principle of design — the same absolute perfection in execution — is equally conspicuous. This exquisite finish is bestowed upon millions of creatures which the eye of man "hath not seen;" "nor hath it entered into his heart to conceive" the faculties and the instincts they possess, still less to form ideas on all the reasons of their creation. Such knowledge, indeed, we cannot attain to in this stage of our existence; but the good shall most assuredly enjoy it in their next.

(263.) The GADIDÆ, or cod-fish, form our third division of the malacopterygious or soft-rayed order of fishes. The general construction of these has already been intimated (p. 230.). They form the first of the aberrant division of the order, and are placed by Cuvier next to the *Pleuronectidæ:* that eminent anatomist, indeed, has included them both in one order, distinct from the *Salmonidæ*, because the ventral fins in both are placed under the pectorals; nevertheless, as we find that by this character the lump-fish, suckers, &c., forming the *Cyclopteridæ*, are made to follow the cod-fish, it becomes plain that such a principle of arrangement unites discordant groups, and cannot be followed in a natural system. We shall first make a few observations on the general peculiarities of this family, and then explain its component parts.

(264.) The cod-fish are chiefly found in the cold and temperate seas of the northern hemisphere, for none have as yet been described as inhabiting India or the great Pacific Ocean. The common cod, whiting, haddock, hake, and several other well-known species, although of a small size, belong to this family, and are well known for the abundant supply their prolific numbers furnish to man. The fishery for cod on the banks of Newfoundland is much more important than that of

the herrings on our own coasts, since it gives employment to more men and a greater amount of capital. It has been estimated that 20,000 sailors are annually employed in this fishery, which is carried on, not in decked boats, but square-sailed vessels. An official report of the French minister stated that, in 1792, no less than 210 vessels, amounting to 191,153 tons burthen, sailed from the ports of France with the sole purpose of prosecuting the cod fishery ; and it has been supposed that more than 6000 vessels of all nations are so employed, partly on the coasts of Norway and Sweden, but chiefly on those of Newfoundland and the adjacent parts. Thirty-six millions of fish are supposed to be thus captured, salted, and dried, which are carried to all regions of the world. We have eaten them, under the name of *stock-fish*, in all parts of the Mediterranean, brought by our English vessels ; and they are to be had in all parts of the Brazilian empire—being carried on the backs of mules from the sea coast into those provinces of the interior where fresh fish cannot easily be procured. The annual destruction of such innumerable hosts of cod might be supposed, by some, to threaten the total extermination of the species, but a bountiful Providence — which has signally appointed this to be one of the most useful fishes to man — has given to it the most extraordinary powers of reproduction. We have stated that the annual captures may amount to 36,000,000: now, it is on record that 9,000,000 of eggs have been found in the roe of one female; so that, if only one half of these were hatched and grew to maturity, nine female cods would supply the destruction occasioned by the captures of all the fisheries in one year. So far, therefore, from their extermination being probable, the only wonder is that they have not so increased, in a series of ages, as to fill the ocean, like the sand upon the shore. We can only suppose that they are kept within due limits, not by man, but by the millions on millions of fry which are fed upon by innumerable other fishes and other marine animals: sea birds prey upon them when

older ; and sharks and other fishes attack and devour the full grown ones. To support such countless swarms, there must also be a corresponding fecundity in those animals upon which they feed : these appear to consist of crabs, worms, shell-fish, &c., which frequent the bottom, near to which the cod is almost always found. Great numbers are caught all round our own coasts, particularly on the north and west of Scotland, where, as Mr. Yarrell says, most extensive fisheries are carried on; so that, even in the United Kingdom — which can only be compared to one of the suburbs of the great metropolis of the cod, which is Newfoundland — the catching, curing, and sale of this fish employ thousands of individuals. The cod is caught invariably by hook and line ; and they are so voracious, that they bite at almost any bait. On the banks of Newfoundland, one man will sometimes catch from 400 to 550 fish in ten or eleven hours ; and the master of some fishing vessels told Mr. Yarrell, that " eight men, fishing under his orders, off the Dogger-bank, in twenty-five fathom water, have taken eighty score of cod in one day." " The largest cod-fish," observes the same author*, " I have a record of, weighed 60 lb. : it was caught in the Bristol Channel, and produced five shillings ; it was considered cheap there at one penny the pound." In Pennant's time, however, the price was even less; for he mentions one caught at Scarborough, which weighed 78 lb., that was sold for one shilling. How satisfied would be the inhabitants of many of our remote inland towns to pay five times these prices for slices of this most delicious fish !

(265.) The fins of the *Gadidæ,* unlike all others of this order, excepting the flat fish, are thick and fleshy, being covered by the common skin of the body. Hence the rays of many, being slender and close together, cannot always be counted — at least with any degree of certainty : the mouth is always large ; and the jaws, with the fore part of the vomer, are furnished with several

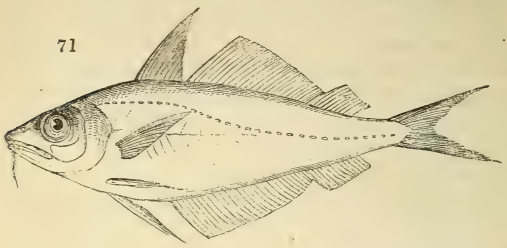
* Brit. Fishes, vol. ii. p. 147.

rows of pointed, irregular, rasp-like teeth of different sizes, but none of them very long: the aperture of the gills is always large. It is in this group only, of all the soft-rayed families, that we find three dorsals; but their ventrals are almost always imperfect, — that is to say, three or four of the rays are either excessively small or totally wanting. This circumstance, with their fleshy fins, their depressed head, and their length of tail, are all so many proofs of their analogy to the apodal or anguilliform order.

(266.) The whole of the genera defined by modern ichthyologists, together with two others now intimated for the first time, we shall arrange under the five following divisions, which may be considered as sub-families: — 1. The *Gadinæ*, or typical cods, having always two anal fins, and generally three dorsal ones. — 2. The *Merlucinæ*, or the hakes and rocklings, where the dorsal fins are only two: these, being the two typical forms, possess the additional character of having five distinct rays to their ventral fins, although the posterior ones are usually very small, while the first or second is much lengthened and pointed. — 3. The *Phycinæ*, or forked hakes, so called from the ventral fins being each composed, apparently, of a single ray forked towards its middle. — 4. The *Brosminæ*, where there is only one dorsal; but the ventral is with five rays. — And, lastly, the *Brotulinæ*, or eel-shaped cods, having the dorsal, anal, and caudal fins united.

(267.) The genus *Gadus* of Linnæus, as represented by the common cod (*G. morrhua*), stands at the head of the entire family, as well as being the type of the *Gadinæ:* with this well-known fish we associate the dorse, haddock, pout, poor, and speckled cod of Britain, together with certain other species found in the Mediterranean, two of which do not appear to be described. All these have six rays to their ventral fins; but the two first are only well developed; and these being lengthened by a fleshy filament, give the fin a very pointed shape: the caudal fin is always more or less lunated; but in one species

(*Gadus furcatus* Sw., *fig.* 71.) we discovered in Sicily, the tail is forked: they have, moreover, a short cirrus, or barbel, at the point of the lower jaw; but this is



wanting in the next genus, *Merlangus* Raf., although, in every other respect, the structure is the same. The next type we have named *Tilesia*, after its first describer, professor Tilesius, well known as one of the most eminent naturalists that Russia has produced. There is something so peculiar in the elongated form of the *Gadus gracilis* of this author *, joined to the truncated form of the caudal fin, that we venture for the present to keep it distinct from *Gadus*, with which, however, it agrees in having a barbel and three dorsal fins; but these latter are represented as all of the same size, — a proportion not observable in any other of the cods, where the first dorsal is always higher and shorter than either the second or third: the truncated or slightly rounded tail of this fish prepares us for *Lepidion* Sw., represented by a most singular species of cod, described as very rare in the Mediterranean by Risso, who has likewise given a rude figure of it: in this the dorsal fins are only two; and the two anal fins are so much united, that they appear almost as one that is deeply cleft. Risso describes it, however, as a *Gadus*, which, in all other respects, it resembles. It is a remarkable circumstance, that, of the two species he

* Icones et Descrip. Piscium et Vermium Zoop. Camtschaticorum Petropoli, 1810. This rare work is in the library of the Linnæan Society.

mentions, one has the tail truncated or slightly rounded, while in the other it is, as he says, bifid: we reconcile this difference by supposing that his *Gadus Lepidion* (our *Lepidion Rissoii*) connects with *Tilesia;* and that his *Gadus Moro* (our *Lepidion Moro*), which has the "*cauda bifida*," prepares the way to the last type, or *Cephus*. The only species yet discovered of this extraordinary type is the *Gadus macrocephalus* of Tilesius (*fig.* 72.):

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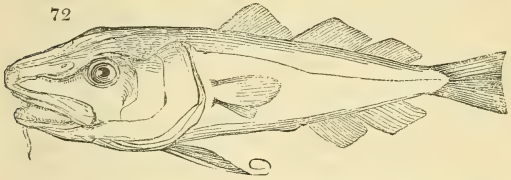

the head is so enormously large, that it is nearly half the length of the whole fish, and is much thicker than any part of the body; the crown also is depressed; and the whole fish immediately gives the idea of a gigantic *Raniceps;* but having the three dorsals, and all the other points of structure of the true cods, except that the tail is truncate, and the gills covered with scales.

(268.) The *Merlucinæ* are less numerous in species, and in the variation of their forms; and thus we know of only three genera. To the first of these, named by Rafinesque *Merlucius**, after the *Gadus Merlucius* of Linnæus, belongs the common hake, peculiar to northern seas, with which the Mediterranean hake (*M. sinuatus* Sw., *fig.* 73.), now for the first time described,

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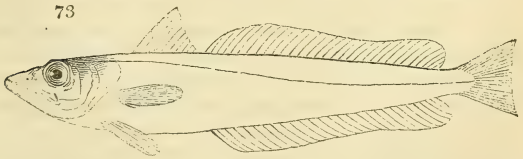

* Carattari, &c. Palermo, 1810.

has hitherto been confounded by all writers: we presume this is the species, which, under the belief that it was the common one, Cuvier says is abundant in the Mediterranean. A third species, under the name of *M. Smiridus* *, is mentioned by Rafinesque, as being rarely found on the Sicilian coast; but his description, unfortunately, is so short, that the only definite character we can discover is that the dorsal fins are nearly equal: this we have never seen, as it was caught on a part of the coast we did not explore. The next genus is *Lota:* it is composed of more elongated fishes than any of the preceding: their body, as well as the form of the head, has more analogy to the eels, and the caudal fin is rounded; the under jaw, as in *Gadus*, is furnished with a cirrus. The ling seems the largest, and certainly the best known, of this genus. We remember catching many of this fish off the southern coast of Ireland, by a common hook and line thrown out from the vessel: it is a particularly voracious fish, and is generally from two to four feet long; but Pennant mentions one that measured seven feet. The other British species, *Lota vulgaris,* or the burbot, is the only species among the British *Gadidæ* that is fluviatile: we shall quote Mr. Yarrell's remark on this species, in further confirmation of our theory that this family represents the apodal order among the soft-rayed tribes. "The burbot," observes this excellent ichthyologist, "is not unlike the eel in some of its habits,—concealing itself under stones, waiting and watching for its prey; it feeds, also, principally during the night, and, like the eel, is most frequently caught by trimmers and night lines." The third and last genus which enters into this division is that of *Motella*, or the rocklings: these are much smaller and even more eel-like fishes than the foregoing: they are peculiarly distinguished by having cirri at the tip of both jaws, and by the singular structure of the first dorsal fin, which is altogether

* *M. Smiridus.* "Capo quasi troncato diagonalmente, ale dorsale quasi uguale."—*Caratt.* p. 25.

unique among fishes: the rays are excessively slender, and are composed of fine fleshy filaments, without any internal bony support; so that they can scarcely be discerned when the fish is out of the water: the first ray is always the longest; and it exactly resembles in shape, appearance, and substance, the cirri or beards on the snout. Several species occur on our own coasts, and others inhabit the Mediterranean: one of these (*Motella fusca* Sw., *fig.* 74.) is here represented, as a perfect type

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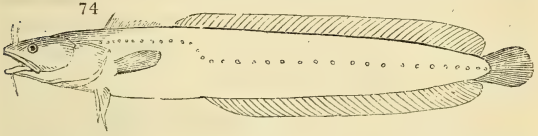

of the whole group; its description will be found in the Appendix.

(269.) The *Phycinæ*, or forked hakes, form a natural succession to the rocklings: they are not so much distinguished by their greatly depressed head and their two dorsal fins, as by the peculiar construction of the ventrals, which consist but of one long and cylindrical ray, divided about half way into two unequal parts. Between these and the last we have the intermediate genus *Raniceps* of Cuvier, whose first dorsal is like that of *Motella*, but whose depressed head may perhaps place it within the confines, as an aberrant genus, of the present group. Its ventrals also partake of this intermediate character: there are, indeed, six rays, as authors assert, in each fin; but three of these are so minute as to be nearly obsolete, while the two outer are long and detached, so as to resemble the forked single ray of the next genus. *Raniceps* thus becomes the link of connection between *Motella* and *Phycis*; and the possession of a single cirrus on the lower jaw makes the passage more gradual from the bearded rocklings to the forked hakes, which have none of these appendages. There seems to be much confusion among the species of *Phycis*, ori-

ginating in a great measure from the prevalent custom of assimilating the species peculiar to the Mediterranean with those found in our northern seas. Cuvier, indeed, being aware that there is one species found in the Mediterranean different from ours (his *Phycis furcatus*), justly enough supposes that it was the true *Blennius Phycis* of Linnæus; but we have reason to believe that no less than three inhabit the coasts of the south of Europe. Two of these we discovered in Sicily, and shall subsequently describe in detail. One of them, our *Phycis longipinnis* (*fig.* 75.), will serve as a typical re-

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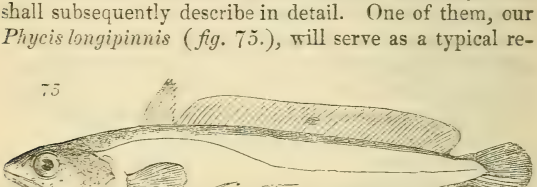


presentation of the whole; and the other, *Physis Siculus* Sw., will be found in the Appendix. We believe that others from the same seas will be hereafter detected, so soon as the Mediterranean fishes undergo a more rigid comparison with those of the German Ocean, than has hitherto been deemed necessary.

(270.) The *Brosminæ*, at present, are represented only by a single genus, of which the *Gadus Brosma* of Linnæus forms the type. We have placed this as a representation of one of the principal divisions of the family, because it seems to hold an intermediate station between *Phycis* and the next group. The first dorsal or anterior fin here disappears, leaving only one, which begins immediately above the pectoral, and only terminates at the very commencement of the caudal: the ventrals are like those of *Lota* and *Motella*, but as fleshy as in *Phycis;* and there is a single cirrus on the lower jaw. The only species known, or, at least, that has been de-

termined, is a northern fish, seldom reaching to the length of three feet and a half.

(271.) The *Brotulinæ*, or eel cods, will terminate the series. In *Brosma* we have been prepared, by the close approximation of the dorsal and anal to the caudal fin, for that union of all three which takes place in the group before us. This is precisely the structure common to the true eels; and thus we have a perfect representation of the apodal order in the circle of the *Gadidæ*. No British example of this type exists. The only two genera that can certainly be placed in this group are *Brotula* Cuv. and *Pteridium* Scopoli. Of the first, only one species is obscurely known; it has six barbels, and is found on the coast of Cuba. *Pteridium* Scop., on the other hand, is a Mediterranean genus; and although so long established, both by Scopoli, and subsequently (under the name *Oligopus*) by Lacepede, it is altogether omitted in the *Règne Animal*. Risso describes and figures one species (*P. niger*), which perfectly resembles, in its general aspect, the genus *Ophidium*, except in having no cirri under the chin, and in possessing small, slender ventral fins, composed of a single ray.* It will subsequently be shown, when we come to treat of the genus *Ophidium*, that this is the precise point of union between the two great orders of osseous fishes, or that which forms the passage from the *Malacopteryges* to the *Acanthopteryges*. The silvery *Ophidium* of the Mediterranean, in fact, has so strong a resemblance to the present family, that it may almost be termed a *Gadus* without ventrals: it grows to as large a size as some of the *Phyces*, and has just the same formed head, mouth, and teeth; the same silvery body, minute scales, and fleshy fins; they live in the same situations; and they are so alike in taste, — the flesh of both being the same as that of the haddock, — that they cannot be distinguished when cooked. Cuvier brings into this family the remarkable genus *Macrourus* of Bloch, which agrees with *Pteridium* so far as to have the caudal fin

* Ichthyologie de Nice, p. 142. pl. 11. fig. 41.

united to the second dorsal and to the anal, both of which are very long. In all other respects, however, the species of this genus differ so very much from the general structure of the *Gadidæ*, that we cannot think they are naturally located with them. They may, indeed, constitute the most aberrant type, or that which we have assigned to *Brosmius;* but our impression is, that *Macrourus* represents the anguilliform or apodal division of the *Triglidæ*, in which group we have therefore placed it.

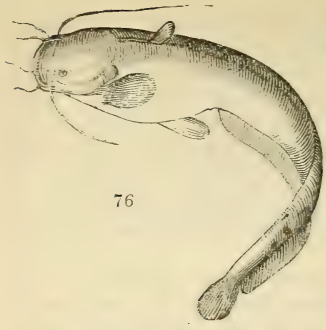
(272.) Without going into an extended exposition of the analogies of this family, it will be sufficient to call the naturalist's attention to those general points of resemblance to the higher types or divisions, which are presented by what appear to be the leading genera of the *Gadidæ*. Thus we have the prevalent character of the cartilaginous order indicated in the very broad and depressed muzzle of *Phycis* and *Raniceps;* while that of the apodal is clearly symbolised in the eel-like form of *Brotula* and *Pteridium*, where the caudal fin is confounded, as it were, with the dorsal and the anal. Further, if we confine our attention to the five sub-genera, here indicated, of the genus *Gadus*, it is not difficult to trace a resemblance to the higher divisions of the whole. This will be best seen in the following table, with which we may conclude our sketch of this family.

Genera of GADUS.	*Analogical Characters.*	Divisions of the GADIDÆ.
Gadus.	Typical: ventral fins two; mouth with barbels.	GADINÆ.
Merlangus.	No barbels.	MERLUCINÆ.
Tilesia.	Body elongated.	PHYSINÆ.
Lepidion.	The most dissimilar from their respective types.	BROSMINÆ.
Cephus.	Ventral fins much pointed.	BROTULINÆ.

CHAP. XI.

ON THE FAMILIES OF SILURIDÆ — THE CAT-FISH, OR SILURES; AND OF THE COBITIDÆ, OR LOACHES.

(273.) The Siluridæ, or cat-fish, are far more numerous than the *Gadidæ*, nor do they yield to the *Salmonidæ* in the number of their species or the diversity of their forms. They are entirely fluviatile, or, at least, have never yet been found beyond the estuaries of the great rivers. Of all fish yet discovered, they have the longest cirri or barbels, — appendages which are doubtless used to allure the prey upon which they subsist, and which, mistaking these slender filaments for worms, bring themselves, unconsciously, within the grasp of their hidden foe. The *Siluridæ*, from all we know of their manners, lie concealed in the mud; and hence they are most numerous in such of the tropical rivers as flow over soft ground, and whose course is not rapid. Some of the Asiatic species are more especially found in ponds, tanks, and even ditches: here they lie concealed in holes along the bank; or are half hid beneath the mud and weeds at the bottom. Only one species, the *Silurus Glanis* Linn. (*fig.* 76.) has yet been found in Europe: it is the largest of all the freshwater fish yet discovered: and seems more especially appropriated to the great rivers of Austria, where individuals have sometimes been captured of an enormous size; in Pomerania they have been taken from twelve to fifteen feet long, with a mouth sufficiently capacious, as it is said, to gorge a child of six years old; another, captured at Writzen on the Oder, is stated to have weighed 400 lb. The flesh is white, and of an agreeable taste. An attempt was made to



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naturalise this species at Strasburg; for which purpose several young ones were brought from Hungary, and turned into the river: this plan has been in some degree successful; for although the fish have not multiplied, in their new abode, so rapidly as was anticipated, yet fine individuals are occasionally caught there, and even transmitted to the Parisian market. In India, most of the larger species are eaten by the natives, and many by the Europeans, notwithstanding the prejudice arising from their lurid colour and repulsive shape. In Britain, we have no proof that this species has ever existed; for although Mr. Yarrell has introduced it into his valuable enumeration of our native fish, he very justly questions the fact of its having been known to Sibbald, who has probably mistaken the burbot for the "*Silurus, sive Glanis,*" of the ancients.

(274.) The form of the majority of these fishes is altogether peculiar, or, at least, we only find partial representations of them in other families. The mouth is small, furnished with fascicles of minute teeth, often so imperceptible, that they have justly been compared to the pile of velvet: these teeth are variously shaped and disposed, but without any of that uniformity which induces us to look to them as organs deserving a primary consideration. In species bearing the closest approximation in all other respects, one will possess teeth, while the other has none*; even when present, they are so very minute as not to be clearly defined,

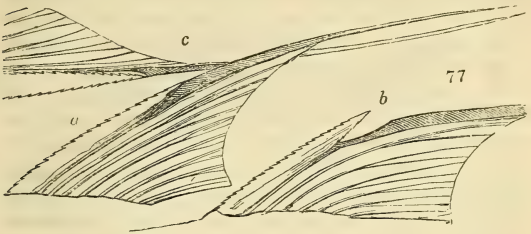
* *Bagris, Pimelodus,* &c. of M. Cuvier are striking instances of the impossibility of classing these fishes by their teeth alone.

except under a high magnifier: hence we may safely infer, that the major part of the *Siluridæ* swallow their food entire; and that, as the mouth is moderate, the fishes they capture must be of a small size. It is more than probable, also, that several of them feed as much upon vegetable as upon animal substances; something in the manner of carp and eels. The worm-like and flexible cirri, or barbels, of the *Siluridæ*, as before observed, is another of their most remarkable distinctions: those on the upper lip are always the most developed, and among the *Pimelodinæ* are often as long as the whole body: these are supported by the intermaxillary bones; and, from their great length, command a much wider range than those on the under lip, which are usually shorter. The head is exceedingly depressed, being often almost flat; so that its height, when viewed in profile, is not more than one fourth, and even less, of the vertical breadth: the mouth is small or moderate, and the eyes by no means equal to those of the generality of fishes. The body is always destitute of true scales, even of those obsolete ones seen in the neighbouring group of the *Gadidæ*, or cods; yet, if naked, it is very slimy; and in the typical group, or the *Loricarinæ*, the whole head, and the greater part of the body, is mailed by hard bony plates, which makes them appear like the mailed ant-eaters of India, and apt representatives of the chelonian reptiles and the loricated fishes. The *Siluridæ*, as we have already shown, are the most aberrant of all the soft-finned order: this at once accounts for the fact, that the great majority of the species have the first ray, both of their dorsal and their pectoral fins, not only spined, but usually very thick; and these rays are rendered sometimes more formidable, as weapons of defence, by having one or both edges finely toothed, with the points directed inward. Dr. Buchannan Hamilton, in reference to this peculiarity of the cat-fish, conjectures that, "in general, every time that they are employed, the animal must suffer considerably, as, in most of the species, these prickles terminate in a

flexible substance, somewhat resembling whalebone ; and before the prickle can penetrate an enemy, this flexible point, which supports part of the membrane, must be broken. Although, therefore, it is probable, that in case of such accidents, the flexible part may be soon reunited to the prickle, yet it is not likely that the animal should have recourse to the use of such a weapon, except in emergency, and perhaps never as a weapon of attack."* To us, however, this subject appears in a different light. From observations made upon the American *Siluridæ*, it appears, that although these rigid spines, in one sense, are terminated by a flexible process, yet that this process is more an additional appendage to the spine, than an integral part thereof; it is, in fact, so articulated, that it can be bent sufficiently back, and that without any injury, to admit the spine being used as a powerful weapon of offence, — the soft appendage by which it is surmounted, returning again to its usual position so soon as the spine is disengaged from any substance it has penetrated. This soft part of the ray, in fact, might, with more propriety, be termed as much articulated to the spined or bony part, as if it moved upon a spring: it may be easily pressed backward, but not forward ; and in every position it leaves the attenuated point of the spine itself completely free. To illustrate this very singular peculiarity, which does not hitherto appear to have been noticed, we annex the accompanying sketches of the dorsal (*a*) and pectoral (*c*) fins of our new genus *Breviceps ;* that at *a* (*fig.* 77.) showing the spine in a state of repose ; while *b* represents it with its soft and articulated termination bent backwards, leaving the point of the spine entirely naked. We cannot say how far this structure is prevalent among those *Siluridæ* we have not personally examined ; but there is every probability that it may be general. Besides, if we take a more general view of the question, there is nothing in nature to make us believe that the

* Gangetic Fishes, p. 139.

means provided by Almighty Wisdom for the defence,



and consequent protection, of his creatures, should be accompanied by injury, pain, or distress in its use.

(275.) The classification of this family, as it at present stands, is involved in greater confusion than it is to be found, perhaps, in any one group of ichthyology. Several of the subordinate divisions were pointed out by the illustrious Artedi, the father of scientific ichthyology, and were adopted by Linnæus in the earlier editions of the *Systema Naturæ;* but, from a mistaken idea of simplification, which the celebrated Swede appears subsequently to have conceived, he incorporated all these genera under the common one of *Silurus.* In this, however, he was not followed by either Gronovius or Bloch, each of whom characterised several others. Lacepede next separated the *Pimelodes* from the *Siluri;* but, by mistaking the true distinction of these two groups and founding his primary character upon one of secondary import, his arrangement, as will subsequently appear, became artificial. All these, with two or three additional divisions, were incorporated in the first edition of the *Règne Animal.* It is somewhat singular, notwithstanding the important additions since made to this family—not merely in species, but in the discovery of new and extraordinary types by Humboldt, Spix, Agassiz, and Buchanan, as well as intimations of others in the French Museum — that Cuvier should have merely noticed a few of these discoveries in the way of incidental notes;

so that his arrangement of the *Siluridæ* is virtually the same in the last edition of his *Règne Animal* as it was in the first. Great alterations, no doubt, would have been made in his general work on ichthyology; for it must have been evident to himself, that, as the family now stands, it is much in the same state as those of *Falco*, *Sylvia*, and *Muscicapa*, among birds, once were, when Linnæan authority was considered paramount to that of nature. With a hope, therefore, of laying some foundation for a natural arrangement of this group, to which for many years we have felt much attached, we shall now submit to the ichthyologist our latest views on its internal and external relations. Although this will be the result of much personal investigation, it would be injustice not to add that this could never have been accomplished, but for the invaluable labours of Spix, Agassiz, and Hamilton, whose admirable descriptions and characteristic figures have made us almost as well acquainted with the *Siluridæ* of Tropical India and America, as if we had personally examined all the subjects themselves.

(276.) The natural station of the SILURIDÆ, in the circle of the present order, has already been investigated. By occupying an intermediate station between the *Gadidæ*, or the cod-fish, and the *Cobitidæ*, or loaches, it becomes the most aberrant family of the circle; and thus corresponds to the order of cheloniform fishes, or the *Plectognathes*, and to the class of *Amphibia*. These analogies, which are particularly beautiful, at once account for the fact of our finding among the *Siluridæ* a far greater proportion of mailed fishes than exist in any other group, either of the *Malacopteryges* or of the *Acanthopteryges:* it is this peculiar character, in short, which marks the typical perfection of the whole. Our first division, therefore, or sub-family, is composed of the *Loricarinæ*, or mailed cat-fish: they are distinguished, like the *Lor. plecostomus* Linn. (*fig.* 78.), by the head and body being covered, more or less, by hard osseous plates, forming large rude scales; and especially

by the situation of the mouth, which is always placed beneath. The sub-family of *Pimelodinæ* next succeeds:

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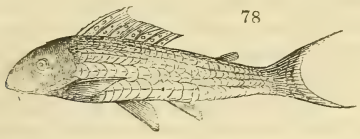

this is a much more numerous division than the last, from which, although the body is sometimes partially mailed, it may be further distinguished by the mouth being terminal, or but seldom placed beneath the snout. It likewise comprises all those silures whose belly, as in the generality of fishes, is of equal length with the tail, so that the vent is nearly central between the pectoral and the caudal fins: this structure carries with it, almost universally, a peculiarity in the proportionate length of the anal fin, which is never very long, as in the succeeding division; nor are the number of dorsal fins ever less than two, the hinder of which is always adipose. The third sub-family includes the true *Silurinæ*, or anguilliform cat-fish, well represented by the genus *Plotosus* Bl. (*fig.* 79.). They are immediately known

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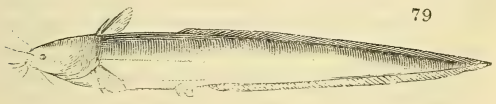

from the *Pimelodi*, with which they have hitherto been confounded, by the excessive length of their tail, which is always more than two, and often four, times the length of the abdomen: this structure produces a corresponding modification of the ventral fin, which is always exceedingly long and low, so as in nearly all cases to exceed one half the length of the entire fish. Like the *Loricarinæ*, we find that the two typical genera of the *Silurinæ* are distinguished by the presence or absence of a small adipose fin; although, in all other respects, their

organisation is essentially the same. The great developement of the tail, however, from being the primary characteristic of the whole group, may be traced in all the aberrant types, notwithstanding the numerous variations they present in other parts of their structure. Quitting these, however, by means of the eel-like genus *Plotosus*, we enter at once into the fourth sub-family, represented by the genera *Aspredo* of Artedi (*Asp. Gronovii* Sw., *fig.* 80.) *Platystacus* (in part) of Bloch, and two

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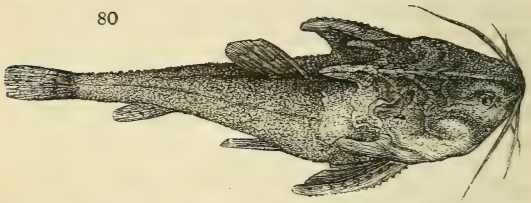

or three others. The first of these is probably the type of the whole: they are distinguished by the excessive smallness of their eyes, which are vertical, or placed close together on the top of their head; and the aperture of the gills is merely a simple cleft of the skin, as in the *Plectognathes*, or cheloniform genera. Here, also, we arrange the remarkable genus *Astroblepas* of Humboldt*, one of the most extraordinary fish in the whole family, since its connection to certain *Mysti* of Gronovius is quite evident. In the *Heterobranchus 5-tentaculatus* of Spix, the head is protected or mailed by bony plates, as in the *Heterobranchi* of Egypt; while its lengthened muzzle shows such an affinity to the *Sorubinæ*, that we consider its real affinities to be with these latter fishes. The genus *Sorubium* of Spix we place after the *Aspredinæ:* in these the dorsal fins are two — the hinder one being either adipose, or with imperfectly developed rays: the head, however, has now become uncommonly long and large, the muzzle obtuse and dilated, and the upper jaw considerably longer than the under. We cannot fail

* This is not alluded to by M. Cuvier, even in his notes.

to recognise in these characters the genuine indication of the broad-headed or cartilaginous type of animals; for they are not only the primary external marks by which that type is distinguished, but are almost peculiar to this division of the *Siluridæ*. The same form, indeed, but differently modified, is seen in the *Sturisoma rostrata**; so that we once more enter among the *Loricarinæ*, with which we began our survey, and the circular succession of all the sub-families becomes sufficiently evident.

(277.) Let us now compare the preceding divisions with the primary orders of fish, placing each in the natural series of their succession. This comparison, also, will elicit several other characteristics of the Silurian groups which have not been yet touched upon.

Sub-families of SILURIDÆ.	*Analogical Characters.*	Orders of FISHES.
Loricarinæ. *Pimelodinæ.*	The two most typical groups in their respective circles.	MALACOPTERYGES. ACANTHOPTERYGES.
Silurinæ.	Tail excessively long; the caudal, anal, and dorsal fins often united.	APODES.
Aspredinæ.	Eyes small, vertical; gills immoveable.	PLECTOGNATHES.
Sorubinæ.	Muzzle long, broad, protruded beyond the mouth.	CARTILAGINES.

We need not again advert to the difficulty that arises, in some cases, of determining the more particular analogies of the two typical groups of one circle, with those of another circle; which, as we have had frequent occasion to observe, appears to be sometimes reversed. In such cases we must fall back upon the strength of our *affinities*, and leave the analogies to be explained in a more advanced state of the science. No one, however, can deny that the *Loricarinæ* and *Pimelodinæ* follow each other, and this in as unquestionable a manner as the soft-finned fishes are succeeded by the spined order. These points, therefore, being determined by absolute affinity,— an affinity acknowledged by all writers,— it follows, from the collateral evidence derived from the other groups, that these four are analogous to each

* *Loricaria rostrata* of Spix.

other. As the *Siluridæ* are the most mailed of all the soft-finned fishes, they thus become analogous to the tortoises, or chelonian reptiles, and to the cheloniform fishes; hence it is natural to suppose that the *Loricarinæ*, from being the most mailed, are those which should stand at the head of the family. On the other hand, the *Pimelodinæ*, in point of general structure, appear to be the most perfectly formed, or, rather, the most highly organised, of the two: their body, indeed, is naked, but they have all two distinct dorsal fins; and those cirri, which are few and short, or altogether wanting, in the *Loricarinæ*, are here developed to an enormous length, more especially in those of the New World. Leaving these, we may proceed to the other comparisons, where the analogies are so strong that they must strike every one who has paid any attention to this most fascinating department of zoology. The *Silurinæ*, indeed, are not, like the eels, destitute of the ventral fins, for then they would actually become apodal fishes; but the great development of their tail, their rounded caudal fin, their dark lurid hues, and their natural habits, leave nothing more to be desired on this head. It is proper, also, to observe in this place, that what has previously been said on the habits of the European species (*Silurus glanis*), must be looked on as more particularly applicable to this division, rather than to the other sub-family of the *Siluridæ;* about which, in fact, we really know little or nothing. The analogy between the *Aspredinæ* and the *Plectognathes* is rendered perfectly conclusive by the structure of the gill-covers, which in these two groups are immoveable. Again, it may be observed as a general rule, that, on comparing any natural group of fish with the primary orders of the class, we shall almost invariably find that those whose eyes are small, and situated at the top of the head, turn out to be the most aberrant in their own circle: now, this is explained by looking to the order *Plectognathes*, where we find both the *Balistidæ* and the *Chironectidæ* possessing this structure in a remarkable degree. The

same peculiarity is apparent in the most aberrant of all the apodal fishes, where the eyes, as in *Myxine*, are totally wanting. All these facts are in full accordance with our theory (or, rather, we should say they have been the foundations of the theory), that the most aberrant group of a circle is always that which is least organised: the class *Acrita* in the animal kingdom, the *Amphibia* among the *Vertebrata*, the *Vermes* among the *Annulosa*, and innumerable other instances, are too well known to require enumeration; and we now have a further instance in the circle of the *Siluridæ*. Finally, we come to the relations of the *Sorubinæ* with the cartilaginous order of fishes, and the fissirostral type of birds: the discovery of this group in the rivers of Tropical America, by the lamented Spix, and the masterly description of its peculiar structure by Agassiz, has thrown a light upon this family, we have been waiting for several years; while the no less important discovery of *Sturisoma*, by the same traveller, establishes two of the most important facts in the natural arrangement of the family; — one showing us a group with the flat protruded muzzle of the sharks; the other, the manner in which the whole of the groups we have now reviewed, close into a circle. Did our space permit us to extend these analogies to the *Triglidæ*, the order *Plectognathes*, and some other groups, many new and interesting illustrations would result; but there is so much to be said on the internal relations of the *Siluridæ* among themselves, that we must proceed at once to a more detailed account of the variations of structure observable in each of the sub-families we have now designated.

(279.) At the head of the *Loricarinæ*, or mailed catfish, stands the genus *Loricaria*, distinguished by having the whole of the body (excepting the belly), together with the head, covered by large osseous plates, resembling rude scales; the back being furnished with a single dorsal fin. There are not many species, and therefore it might seem premature to divide the contents of

so small a group into sub-genera; yet as this has already been done, in part, by MM. Spix and Agassiz, we shall adopt their divisions. Nearly all the types or sub-genera of *Loricaria* appear to be discovered; and the additional interest that attaches to them from this circumstance, renders it advisable to designate them by sub-generic names. One of the most remarkable of these is *Acanthicus* Sp., where the whole head and body are covered with short acute prickles, placed on the surface of the osseous plates, and even on the first ray of the fins: the caudal fin is very large, deeply lunated, and has the outermost rays greatly lengthened: the cirri are only two, and very short; but even these are slightly barbed, on one side, with setaceous hairs. This extraordinary fish was discovered in the great river of Amazons. *Rhinelepis* of the same author is entirely without these prickles; but the edges of the plates are crenated; the two cirri very short and fleshy; and the tail moderate and only slightly lunate. The *Plecostomus* of Gronovius* is another, and a most interesting form, at once distinguished by the great length of its tail; while the caudal fin has one of its external rays prolonged into a filament, as in *Acanthicus:* this singular fish is probably an aberrant type for it has no cirri; and it thus opens an immediate passage to the next genus, *Hypostoma,* where it is met by the *Hy. etentaculata* of Spix, equally characterised by the absence of cirri, yet having an adipose dorsal fin, which is the peculiar distinction of this genus. There are only two species of these double-finned *Loricariæ* yet known from South America. Following this, we now first characterise the genus *Hoplisoma* (*H. punctata* Sw., *fig.* 81.), the type of which is the *Cataphractus punctatus* of Bloch. Unlike all the mailed silures, the mouth is terminal, as in the generality of fishes: but, it differs from all the others, in having the the body compressed: the cirri are well developed; and although the anal fin is short, the tail is long, so that the vent is very close to the ventral fin: this is, in short,

* Zooph. pl. 2. fig. 1, 2.

a very distinct type, whether we regard the compression of its head and body, or the singular scales with

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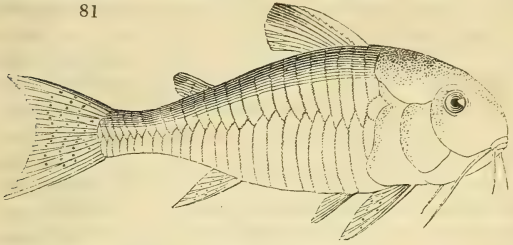

which it is covered. It is followed by another, to which a variety of names has been applied, with little regard either to priority, or propriety, of nomenclature. To give, for instance, the name of *Callichthys*, implying a beautiful fish, to one of the most ugly in the whole family, is manifestly absurd: we shall, therefore, follow Bloch and Lacepede, and retain the old name of *Cataphractus* to that strange-looking fish, figured by Bloch (pl. 377. f. 1.) with the specific name of *depressus*. Its eyes are very small and nearly vertical; the head large and greatly depressed; and it possesses, altogether, the strongest possible resemblance to the *Aspredinæ*: the mouth, indeed, can scarcely be said to be beneath; but the dentated plates which cover the whole body, in two series on each side, are precisely of the same pattern and structure as those of *Hoplisoma*, and plainly distinguish it from all the types of the *Aspredinæ*. Last of all, we have the new genus *Sturisoma* Sw., represented by the *Loricaria rostrata* of Spix, distinguished at once from all the foregoing, by its long obtuse snout, which projects so considerably beyond the mouth, that it has the greatest possible analogy to the sharks. On looking to the slender form of this type, and of the *Loricaria maculata* of Bloch, we see at once that the series of this sub-family forms a most perfect circle: the last-named fish, in fact, would be a *Sturisoma*, had it not the short muzzle of *Loricaria*.

(279.) We are thus brought back again to the point from whence we started; and we find that the genera of the *Loricariæ* describe a circle, whose analogies may be thus expressed: —

Genera of the Loricarinæ.	*Analogies.*	Sub-families of the Siluridæ.
Loricaria.	Body entirely mailed; mouth placed beneath,	Loricarinæ.
Hypostoma.	Dorsal fins always two; the second adipose.	Pimelodinæ.
Hoplisoma.	Tail very long; vent close to the pectoral fin.	Silurinæ.
Cataphractus.	Eyes very small, nearly vertical.	Aspredinæ.
Sturisoma.	Snout lengthened, depressed.	Sorubinæ.

The representation which these genera of the *Loricarinæ* gives us of the primary divisions of the whole family, developes their analogy, likewise, with the primary orders of fishes. It is, indeed, a most interesting circumstance to find that in such a group as this we should have a representation of the *Gymnetes*, or riband-fish, in the compressed shape of *Hoplisoma*, so totally at variance with all the other genera; while the small vertical eyes, and the general aspect of *Cataphractus*, remind us immediately of *Aspredo*.

(280.) The sub-family of the Pimelodinæ is distinguished by positive and negative characters, or, rather, of two which are universal, and of two which admit of some partial exceptions. The mouth, in the first place, is always terminal: the body, likewise, is naked; for although, in consequence of their close affinity to the *Loricarinæ*, some few of these fishes have a single row of small plates upon their sides, and even on their head, yet these plates never extend beyond the nape. They have all two dorsal fins; the hinder being completely adipose, or without any vestige of rays. Their more striking peculiarity, as already remarked, is in the length of the belly and tail being equal, so that the anal fin is never of that exceeding length which it is in all the *Silurinæ*. Some idea of the numerous modifications of form that enter into this group, may be gathered by looking to the contents

of M. Cuvier's divisions (or sub-genera, as they are termed) *Pimelodus* and *Bagrus*, — two artificial groups, which we have found it impossible to understand: to us they appear to be common receptacles for all *Siluri* having two dorsal fins. Commencing, then, our survey with such *Pimelodi* as seem to have the greatest affinity with the last sub-family, we may notice the genus *Synodontes*, where the head is mailed as far as the first dorsal fin; but the body is entirely naked; the muzzle is naked and unusually narrow; while the lower jaw is armed with numerous hooked flexible teeth, of a structure altogether unique, as M. Cuvier observes, among fishes: it would appear, however, that this is not strictly the case, for the teeth of *Hypostoma etentaculum* of Spix are similarly formed; while they are, no doubt, articulated or flexible at their roots, in the same way as in *Synodontes*; otherwise they would be useless, as the hooks at their end could not act. Close to this type, well represented by *Syn. Ruppelli* (*fig.* 82.), Cuvier places Lacepede's genus *Agenieosus**,

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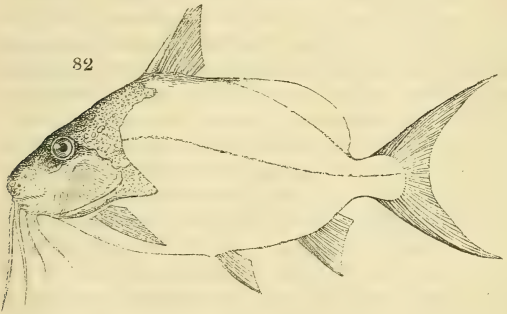

founded on the military or horned silure of Bloch (pl. 262.), and with which he associates the *Pimelodus Silondia* of Hamilton (pl. 9. f. 50.); but as both these fishes have the belly much shorter than the tail, they do

* *Ageniosus* of our Synopsis.

not enter among these types. The two primary divisions of this sub-family may be thus characterised : — In the first, — to which we retain the name of *Mystus*, as originally proposed by Artedi and all the old ichthyologists, — we see the general form of *Pimelodus*, united with some of the characters of *Loricaria :* the parts before the dorsal fin, for instance, are protected by bony plates ; and on each side of the body is a series of smaller ones, placed in a single row, so as to form a lateral line, armed with prickles, as in our *M. costatus* (Bl. 376.). This structure, in fact, is precisely analogous to the plates of the genus *Trachinus* among the *Scomberidæ*, and many other instances of spiny or raised lateral lines to be found in analogous groups. The simple plates upon the head are not, however, confined to this genus ; nor can they be looked upon as a primary generic character ; since they occur in most of the Indian *Pimelodinæ*, and even in some of the *Silurinæ*. In the next or most typical genus, *Pimelodus*, the sides of the body are always naked : the species of this group are exceedingly numerous in the rivers of India, and several are found in those of Tropical America. We have failed, however, in discovering such characters as would separate these species geographically : for although the majority, if not all, of those with the head entirely naked seem restricted to America, yet those in which this part and the nape are covered with a buckler, are found, with little or no essential variation of structure, in both hemispheres. Among the Indian species, minor differences will be observed, sufficient to constitute sub-genera, easily recognised, and therefore much better understood than if we attempted to arrange them by their teeth, — an attempt which has so signally failed in the two "sub-genera" just alluded to, viz. *Pimelodus* and *Bagrus*. In some of those Indian species which we suspect are typical of the genus *Pimelodus* (as we now propose to restrict it), we observe that the adipose dorsal fin is of such considerable length as almost to fill up the interval be-

tween the first dorsal and the caudal, while it is very low at both its extremities.* Another small group has the adipose fin much shorter, and triangular: the cirri are only four; and the anterior rays of the first dorsal, pectoral, and caudal fins greatly elongated.† A third assemblage have the adipose fin very small, oval, and pedunculated; and here the number of cirri varies from eight to four.‡ It deserves some attention, that, in the descriptions of the above, notice is generally taken of a strong sharp spine, attached to the gill covers,—a character which does not appear to be found in those *Pimelodinæ* of Tropical America which have been described and figured by Spix and Agassiz. We feel convinced that there must be some such difference between the *Pimelodinæ* of these two hemispheres; but this, as well as many other points of structure, have been hitherto passed over by our predecessors, so that we can come to no determination on this point, at least in respect to such species as we have not personally examined. As for attempting to determine the natural sub-genera by the serrature or smoothness of the dorsal and pectoral spines, or even by the presence or absence of naked plates upon the head, we have altogether failed in the attempt. The admirable descriptions, indeed, of Dr. Hamilton, who enumerates no less than thirty-three *Pimelodi* found in the Ganges alone, is quite sufficient to convince the ichthyologist that the above characters are merely specific, and therefore quite unfit to be employed for the construction of sub-genera. One species, in fact, will sometimes differ only from another in having the pectoral spine either smooth or serrated; a third, in the obvious line of affinity, will have it barbed on one side only, or on both; and sometimes the side where the dentations are situated, is different in one species to that of the next. The same remark is applicable to the teeth, even on M. Cuvier's confession; and the descriptions of Dr. Ha-

* Gangetic Fishes, pl. 11. fig. 67. † Ib. pl. 7. fig. 62.
‡ Ib. pl. 31. fig. 57., pl. 23. fig. 60. 66. Russell, No. 169.

milton are to the same effect. The teeth, in fact, throughout the whole of the *Siluridæ*, are so minute, that their structure can seldom be determined, except under the power of a high magnifier. The value of a character can only be determined by its extent; and, according to this rule, we find that it either serves to designate a family, or a species. The fins of fishes, as every one knows, are analogous to the wings of birds; and we were the first, in conjunction with professor Temminck, who employed the modifications of the primary quills as characters for the discrimination of the natural groups among birds. There is consequently good reason to suppose that the same importance should be attached to the structure of these organs among fishes; and the proofs offered in this volume, for such an hypothesis, are not few. The number of the cirri among the *Siluridæ* seem more constant than the characteristics of which we have just spoken: but they do not appear to be sufficient for sub-generic distinctions, when not supported by other and more constant characters.

(281.) Leaving now the two typical genera of the *Pimelodinæ*, we may particularly mention three others, each of which presents some very prominent and peculiar characters; these we shall look on in the light of generic types — not so much from our belief that the two first are really so, but that they may be kept for the present distinct from the two presumed typical groups. The first of these is *Sisor**, which has the head broad, depressed, covered with bony plates marked with tubercles and ridges, and terminating behind in three narrow processes. The cirri are more numerous than in any other *Siluri* yet discovered — amounting to no less than fourteen, all of which, however, are shorter than the head; the lips fleshy; and there are no teeth: the eyes are small, and very high. Between the head and first dorsal fin is a bony plate; and near the latter are five small plates, nearly united, and disposed in a double

* *Sisor rabdophorus*, Hamilt., p. 208.

row: the back, between the first dorsal and the caudal, has a tuberculated bony ridge: the vent is before the middle. The dorsal fins are two: the anterior has the first dorsal ray hard at the base, but soft at its point, the hinder part being indented; the second dorsal has only one short prickle, with a short membrane behind: the pectoral spine is strong and doubly serrated; ventral fins small; anal fin of six rays only. The caudal fin is very remarkable: it is lunate, and of ten rays; the uppermost one of which is so much prolonged, like a whip or rod, as to exceed the whole length of the head and body. This great developement of the caudal or tail fin, and the partially mailed plates upon the nape, lead to the belief that this extraordinary fish forms the passage, in conjunction with *Synodontes*, between the *Loricarinæ* and the *Pimelodinæ*. We have not, however, yet seen a specimen; and unfortunately Dr. Hamilton's description, which we have here abridged, is unaccompanied by any figure. There is some distant resemblance between *Sisor* and the *Silurus Bagre* of Bloch: this latter, however, we shall for the present keep distinct, under the name of *Breviceps*. In this the caudal fin is also lunate; but the points are not extended, like those of the first dorsal and pectoral rays, which reach to a very considerable length: the head is particularly short and obtuse, with the eyes very remote; and there are only two pairs of cirri, one of which is very short. The upper jaw is slightly longer than the under: it is very large, and armed with numerous sharp teeth, very small, placed in two broad rows on the upper jaw, and in one on the under: finally, the tongue is very large, thick, and rounded. We mention these particulars in this place, from a belief that this type shows us the fissirostral genus of the *Pimelodinæ*, or that by which the sharks are represented in this sub-family. The third genus is that by which we distinguish the *Pimelodus cyclopium* of Humboldt (*Cyclopium Humboldtii* Sw., *fig.* 83.), which, because it has an adipose fin, has been suffered until now to remain unnoticed, even as

a sectional division of "the great genus *Pimelodus*." A more beautiful representation of the *Aspredinæ*, and

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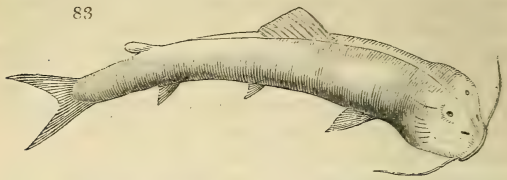

especially of *Astroblepus*, cannot possibly be imagined: the cirri are only two; and, but for its adipose dorsal, this singular fish so much resembles *Astroblepus*, that it might be placed in the same genus.

(282.) Imperfect as is this sketch of the *Pimelodinæ*, we feel persuaded, that, when all the fishes that have been referred to this group are well understood, it will turn out to be one of the most perfect of all the circles in ichthyology. The forms slightly intimated by Cuvier under the heads of *Pimelodus* and *Bagrus*, are so numerous, so varied, so singular, and their characters are so differently combined, that every shade of variation promises to exist in these two magazines of forms. With the hope of finally working out the whole of these, we have long been collecting drawings and specimens of all the species; and we take this opportunity of soliciting the assistance of all those wellwishers to Science, who, by residing near the great rivers of India or America, have it in their power to assist us with correct drawings made from the fresh subjects. Numerous as are the *Siluridæ* yet discovered, we believe that as many more remain unknown; and that, when all the subordinate types are discovered or ascertained, each genus will possess its five sub-genera, representing those of the sub-family we shall now enter upon.

(283.) The true Silurinæ form that division of the family which represents the eels or apodal fishes: this relation is at once manifested by the excessive length of the tail, in comparison to that of the abdomen (as

seen in *Silurus laticeps*, *fig.* 84.): it consequently re-

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sults that the vent is much nearer to the pectoral fin than to the caudal, and that the anal fin is unusually long: this is almost the universal character of every fish within the circle; although in some of the aberrant genera it is, of course, less conspicuous than in the more typical. The first type that meets us, after quitting the *Pimelodinæ*, is *Ageniosus*, at present composed of only three known species, which belong to two sub-genera. In *Ageniosus* proper, we place the *Silurus militaris* of Linn.*, remarkable for having the intermaxillaries developed in the form of two suberect bony and serrated spines, resembling horns, which are placed before the eyes: the head, as in *Breviceps*, is broad and depressed; the mouth very wide; and the first ray of the dorsal greatly elongated. The second sub-genus we have named *Silonia*† (*S. lurida*, *fig.* 85.), as apparently

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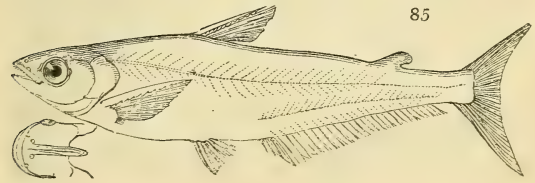
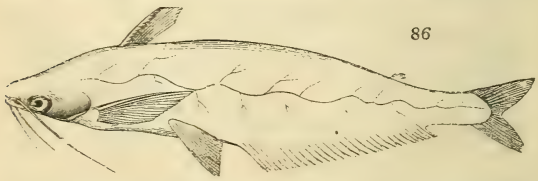


the true type of the genus. Although in this type there are two cirri, yet they are so small as to be nearly obsolete: it thus seems to connect *Ageniosus* to the genus *Pachyp-*

* Bloch, pl. 362. † *Pimelodes silondia*, Hamilt. pl. 7. fig. 50.

terus, where the cirrci are fully developed. In other respects, the general form of *Ageniosus* and *Silonia* are very dissimilar. In the latter the head is short and thick, but very slightly widened or flattened: the whole fish, indeed, is much compressed, and the lower edge, as Dr. Hamilton says, is "sharp, somewhat like a knife," or, in other words, carinated: the mouth is moderate; the eyes are large; and the whole appearance of the other parts is more in accordance with ordinary fishes than with any of the present family. One species is diaphanous*, the viscera being inclosed in a bright silver-coloured membrane, analogous to that of *Argentina:* the two cirri are even more minute than in the last, being scarcely visible without the aid of a magnifier; and in both these speces the gill membrane has numerous rays. As the other subordinate types of this genus remain to be determined, we shall hazard no conjectures upon them, but at once proceed to the next, which we propose to designate *Pachypterus*. In this there is still a second adipose dorsal fin, but the cirri are very conspicuous; and the tail is considerably more lengthened, so as to be often near three times the length of the abdomen: it is bordered beneath, for nearly its whole extent, by the anal fin. We cannot, at present, determine more than two of the sub-genera belonging to this group;—one from India, which is the typical, includes many species; the other, which is the *Hypopthalmus* of Spix (*fig.* 86.), and of



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which two are known, seems peculiar to the rivers of America. The second dorsal fin is reduced to so small a size, that it becomes almost obsolete. We next pass to the genus

* *Chandramara*, Ib. p. 162.

Silurus, the most typical group in this sub-family, all of which are known by a single and very short dorsal fin, a very long anal fin, and a distinct caudal, either rounded or lobed. We may enter the genus *Silurus* by the *Silurus garua* of Dr. Hamilton, which forms the type of our sub-genus *Clupisoma:* this singular fish is almost a counterpart of *Silonia*, except that it has but a single dorsal fin, and the muzzle is provided with eight moderately long cirri. Had we not analysed this group more than the others, we should certainly have imagined these two singular types passed into each other; and, indeed, so long as the circularity of the genera *Pachypterus* and *Ageniosus* remains undetermined, there is still a probability of such being the case: yet this, although it might somewhat affect the contents of those two genera, would not alter this; for in its fins and cirri it is so truly a *Silurus*, that even Dr. Hamilton refers it to that genus. Following this, we place the sub-genus *Callichrus* Ham., distinguished by all the species having a forked tail. These fish, as the doctor observes, are rather handsome, and have little or nothing of that lurid appearance by which the neighbouring species are distinguished: they are all very rich, fine-flavoured food; and grow to from nine to twelve inches in length: they are chiefly found in the ponds and ditches of Bengal; and, no doubt, many more than the five species already known remain undiscovered. The caudal fin is always lobed; the sides of the body are sub-diaphanous; the head is only slightly flattened (thus presenting an affinity, in these two last characters, to *Clupisoma*), the mouth large, and the upper jaw much longer than the lower: the eyes are small, and are on the sides, noe towards the top, of the head; while the gill membranhas nine rays. Quitting these bright-coloured fishes, we enter among those to which we retain the sub-generic name of *Silurus*. They are at once distinguished from the last type by having the caudal fin rounded: the body is much *com*pressed, while the head is remarkably *de*pressed: the mouth is moderately large, and opens

horizontally: the first ray of the dorsal and pectoral fins varies in almost every species; sometimes it is smooth, and sometimes serrated on one or on both sides. The head does not turn upward; and the jaws are about equal. The *Silurus glanis*, already mentioned, together with *S. fossilis* (Bloch, pl. 370. f. 2.) and *S. laticeps*, *fig.* 84.), are typical examples of this structure. Following this, we place the sub-genus *Malapturus* of Lacepede, represented by the electric silure of the Nile, — a fish which is said to possess all the properties of the torpedo and of *Gymnotus electricus*, although in an inferior degree. This sub-genus is distinguished from all the rest of the *Silurinæ*, by having the small dorsal fin entirely adipose, and placed close to the end of the tail, adjoining the caudal fin. The head is turned upwards, but the upper jaw is manifestly longer than the under. Two very interesting species* have recently been figured from general Hardwick's collection of Indian drawings: in one of these there appears a series of small spines placed all along the back, in front of the dorsal; but as this is the only apparent departure from the typical structure, we retain it in the present division. The spines in *M. Cuvierii* are certainly analogous to those on the back of the *Acanthonotus* of Bloch, but we cannot for a moment entertain the supposition that these two fishes belong even to the same order.

(284.) The very small size of the ventrals in the sub-genus *Malapturus* deserves notice, for they are almost obsolete, being nearly one fourth less than the pectoral fins. The last type of form which we imagine to enter within this group is *Pusichthys*†; it has, indeed, the body and fins of *Callichrus*; but the snout is turned upwards; and although the head is unusually broad, the mouth is excessively small, and opens vertically, just as

* *Malapterurus* (*Ailia*) *Bengalensis* Gray, *Silurus* (*Acanthonotus*) *Cuvierii*, Gray, Ind. Zool., vol. i. pl. 85. fig. 1, 2. The probability is, that Mr. Gray did not, at the moment, recollect, that the name of *Acanthonotus* had been already used.

† The Arabians call these fishes *Schilbe*, but Cuvier, by some oversight, has omitted to give them a classic name: their humped back has suggested that of *Pusichthys*.

we see in the genera *Mormyrus, Chironectes, Uranoscopus, Trachinus,* and numerous others. So completely, indeed, do these *Silurinæ* remind the ichthyologist of the chironectiform type, that Dr. Rüppell has given the specific name of *Uranoscopus* to a species he has recently discovered in the Nile. This testimony of its analogical relation to the order *Plectognathes* is highly satisfactory, since it is given, as it were, incidentally, or as an insulated fact, without any idea of the inference we have drawn from it.

(285.) We now pass on to the fourth division or genus of the *Silurinæ*, to which we retain the name of *Plotosus* Bloch. With but one exception * (*Heterobranchus bidorsalis* Geoff., *fig.* 87.), all the fishes it contains

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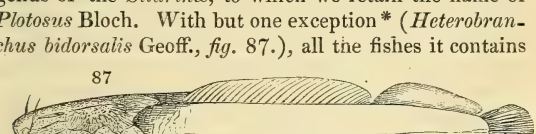

have but a single dorsal; but then this fin, instead of being short and high, is very long and low,—so long, indeed, that it extends to nearly the whole length of the back; the anal fin is nearly of the same length; and both either terminate just before they reach the caudal,

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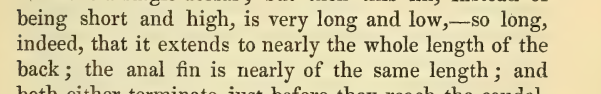

as in the sub-genus *Clarias* (*fig.* 88.), or are actually united to that fin, as in *Plotosus* (*fig.* 79.), the head is still

* M. Cuvier has placed under *Heterobranchus*, certain fishes belonging to the genus *Clarius* of Gronovius, which was subsequently called *Macropteronotus* by Lacepede. As I consider these latter to belong to a distinct type, they are so designated in the Synopsis, under the original name of *Clarias*, imposed on them by Gronovius, which I see no occasion for altering. If these fishes have the same ramified branchia as Geoffroy's *Heterobranchus bidorsalis*, an additional sanction is given for placing the latter fish in the genus *Plotosus*, notwithstanding its possessing two dorsal fins. I must confess, however, that I am not quite satisfied on the true relations of this singular type.

greatly flattened, and the eyes small; but the lower jaw is shortest, and the cirri are usually eight.* Here, then, we have the true anguilliform or eel-shaped silures, distinguished in the most remarkable manner from all those we have yet noticed; and yet so closely allied are they to the last genus, in every thing but their long dorsal fin, that their affinity becomes apparent to every one: the subordinate types or sub-genera, however, are as yet very few, and therefore we cannot state how far the contents of the circle represent that of the last, nor can we trace the connection to the fifth genus,—a genus, however, too remarkable to be confounded with any other; we allude to *Cetopsis* of Agassiz (*fig.* 89.). These

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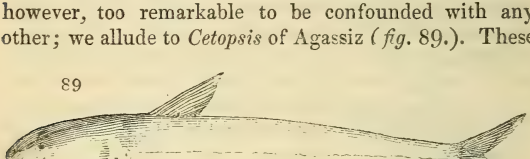

silures present us, in their long anal fins, with the primary character of the *Silurinæ;* but in all other respects show a marked resemblance to *Cyclopium* in the circle of the *Pimelodinæ*, and to *Astroblepus* among the *Aspredinæ:* like these, and all other of their representatives, the eyes are remarkably small—indeed, so minute, that they appear as mere specks in the skin,—and their situation is nearly on the top of the crown: the dorsal fin is single, triangular, and placed near the crown, which is thick and obtuse: the mouth is large, and the gape obliquely vertical: there are no dorsal or pectoral spines: the tail is hardly longer than the body; and the four cirri are so very short, as not to be so long as the head. Now, it is to these two last characters that we must call the naturalist's attention. In commencing our survey of this sub-family, it will be remembered that the first genus,

* *Batrachus*, Bloch, pl. 370. fig. 1.; *M. Hamiltonii*, Hamilt. pl. 26. fig. 45.

Ageniosus, is remarkable for two things;—one, the slight excess of the tail, in regard to its length, over that of the belly; and the other, the almost total disappearance, in *Clupisoma*, of the cirri: these two characters are possessed by *Cetopsis*; and by these points of affinity we consider they pass into each other, and close the series of the *Silurinæ*, which thus becomes, in regard to its genera, a circular group.

(286.) While the affinities we have been tracing, and the forms of the genera and sub-genera, of the sub-family *Silurinæ*, are still before the reader, we will finish our exposition of the whole by looking to their analogies. Commencing with the genera of the *Silurinæ*, we find they succeed each other in the following order; and by placing the sub-families of the whole group also in their own series of affinity, we shall get the following parallel analogical characters:—

Genera of the Silurinæ.	*Analogical Characters.*	Sub-families of the Siluridæ.
Pachypterus.	Dorsal fins universally two.	Pimelodinæ.
Silurus.	Only one dorsal fin in the typical forms.	Loricarinæ.
Plotosus.	"Rostrum round, obtuse, projecting*; the mouth placed beneath."	Sorubinæ.
Cetopsis.	Eyes small or minute, placed towards the crown.	Aspredinæ.
Ageniosus.	Body unusually compressed.	Siluridæ.

Some interesting facts, connected with the general structure and relations of these groups, will result from a more particular exposition of these analogies; resemblances which, we confess, did not occur to us until after we had deemed it necessary to submit our arrangement of the *Siluridæ* to this test. In comparing *Pachypterus* with the *Pimelodinæ*, we see that, throughout both groups, the second adipose dorsal fin is invariably present; and that there is the strongest resemblance between the two is sufficiently established, by the fact of all authors having hitherto actually referred them to the same genus,—an error that has solely arisen from overlooking the great difference in the developement of the

* Russell's description of his *Platystachus anguillaris*, vol. ii. p. 51.

tail, existing between the *Pimelodinæ* and all the true *Silurinæ*. In the typical examples of the two next groups which stand opposite each other, namely, the genus *Silurus* and the sub-family *Loricarinæ*, the adipose dorsal does not exist; and it is further to be noted, that these two genera—*Silurus* and *Loricaria*—are the pre-eminent types of their respective circles. *Plotosus* and *Sorubium* represent each other most completely by their "very large, long, and depressed head*;" and by the snout projecting over the lower jaw, so as to render the mouth inferior, as in the *Squalidæ* and the other typical cartilaginous fishes. Equally beautiful is the analogy between *Cetopsis* and the minute-eyed genera *Astroblepus* and *Aspredo;* and we find a perfect representation of all three in the genera *Cyclopium*, as well as in the types of the cheloniform fishes. We next find *Ageniosus* standing, in our table, opposite to the *Siluridæ;* and this analogy at first sight appears forced, because, as the silures represent the anguilliform fishes, it would seem to follow that *Plotosus*, from having all the hinder fins united, should be compared to them, rather than to the *Sorubinæ:* but further consideration on the nature of the anguilliform type will show this reasoning to be fallacious. Great length of tail is, indeed, one of the chief indications of the anguilliform structure; but it is not the only one, for, throughout the greater part of the representations of this form among the acanthopterygious order, the body is excessively thin; and analysis proves that the highest developement of this particular character is, that the body becomes semi-transparent or diaphanous. Now, by far the greater part of the *Silurinæ* are remarkably thin fishes, — that is, the body is very much *com*pressed, although the head is remarkably *de*pressed. But it is only in our genus *Silonia* (one of the types of *Ageniosus*), that we find both head and body compressed, and this to a much greater degree than in any other forms of the sub-family we are now investigating. Hence it

* Russell thus describes the head of *Plotosus.*

follows that, if *Silonia* had not been discovered, we should have had no precise representation of *Cepola* and all the other riband-like fishes; so that, under this view of the subject, what appeared to be an anomalous form among the *Silurinæ*, turns out to be one almost necessary to preserve that system of representation, and that uniform variation of structure, we trace in all the other groups.

(287.) As we have already shown that the primary divisions of the whole family represent the primary order of fishes, we need not submit the genera of the *Silurinæ* to the same test; because, if they represent, as we think we have now proved they do, the sub-families of their own circle, their analogy to the orders becomes established. We shall, therefore, now call the reader's attention to the different sub-genera of the restricted genus *Silurus*, in order to inquire whether these *sub*-genera do not, in the same manner, represent the genera of the sub-family; the affinities of these sub-genera have already been explained. We shall now, therefore, glance at their analogies.

The sub-genera of *Silurus* have been seen to follow each other thus—	The genera of the *Silurinæ* as already stated, stand in the following order—
Callichrus.	PACHYPTERUS.
Silurus.	SILURUS.
Malapturus.	PLOTOSUS.
Pusichthys.	CETOPSIS.
Clupisoma.	AGENIOSUS.

Our proposition is, that each of these divisions are mutual representations of each other, independent of all those affinities by which the contents of each separate series are united; and we shall now endeavour to substantiate its truth. In the first place, we see *Callichrus* standing opposite to *Pachypterus;* and we find that both have the body brightly coloured, and the caudal fin lobed, in contradistinction to *Silurus*, where the colours are dark and lurid, and the caudal fin rounded. That there is the strongest resemblance between *Malapturus* and *Plotosus*, may be established by the authority, if authority is required, of Bloch, who places them close

together ; in which respect, notwithstanding the essential differences of their structure, he is closely followed by Cuvier. We now come to *Pusichthys:* when we look to the small and nearly vertical mouth, we at once see an exemplification of those peculiarities by which *Uranoscopus*, and all chironectiform types are so singularly distinguished ; this, in fact, is the only sub-genus of the above group that has the mouth opening vertically, while, by the turning up of the snout, it preserves a resemblance to *Malapturus*. The analogy of *Clupisoma* to *Ageniosus* (or, rather, to its type, the sub-genus *Silonia*) is very striking ; the exceeding long cirri of *Clupisoma* and its single dorsal fin, at once show its affinity to *Silurus ;* and yet, setting these peculiarities aside, *Clupisoma* and *Silonia* are so like each other, and yet so different from all their congeners, that they appear almost related by affinity. *Clupisoma* has the same compressed head and body, the same fulness of the eyes, the same sharpness on the edge of the belly, the same semi-transparent sides, &c., as we see in *Silonia ;* yet it has but a single dorsal fin : we are at no loss to recognise, in both, a type of the *Gymnetres*, or riband-fish. Further comment upon these analogies would be superfluous. We now return to the affinities of the remaining sub-families.

(288.) The fourth principal division of the *Siluridæ* is that of the *Aspredinæ ;* the typical distinctions of which are as follows : not only the head, but the anterior part of the body, is considerably flattened, while the tail preserves some resemblance to that of the last sub-family, the *Silurinæ*, in being generally slender ; the eyes are remarkably small, and placed on the crown of the head, so as to become vertical ; the branchial aperture is spiraculated, as in the cheloniform fishes, and consists of merely a slit of the skin ; while the operculum itself, " unlike," as Cuvier observes, " all other osseous fishes, is immovable." These are the positive characters of these singular fishes ; but in other respects they vary considerably. In our new genus *Cotylephorus* (*C. Blochii, fig.* 90.), which connects these to the *Silurinæ*, the anal

fin is very long; but in the more typical forms, such as in

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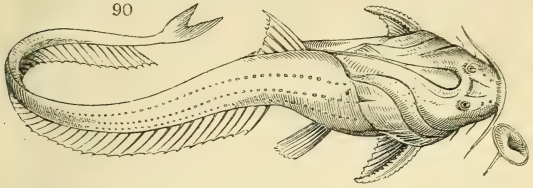

the true genus *Aspredo* Art. (*fig.* 80.), this fin is short. There is but one dorsal fin, which is small, and placed nearest the head; the first dorsal, and the first of the pectoral rays are generally very strong, and more lengthened than usual, and the barbels or cirri always present, although variable in their number; the muzzle projects slightly beyond the under jaw, which is transverse. Cuvier observes that the immobility of the operculum is occasioned by the pieces which compose it being cemented, as it were, to the tympanic bone and to the pre-operculum. These characters apply, more or less, to the following genera:—*Platystachus* Bloch, *Astroblepus* Humb. (*fig.* 91.), and *Aspredo* of Artedi and Gronovius; several

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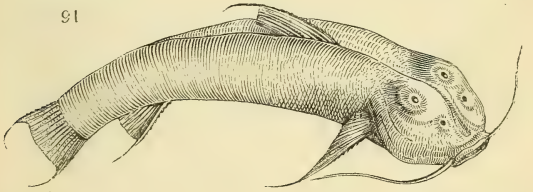
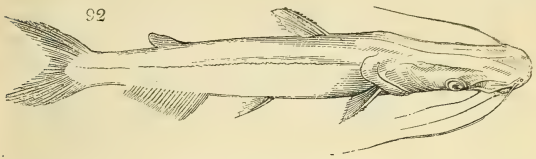


others will doubtless be added, when the subordinate forms in this family are better understood. Now, it will be remembered that we have already designated several genera, equally remarkable with these for the smallness of their eyes, and their depressed head; such, for instance, as *Cataphractus*, *Cyclopium*, and *Cetopsis*; but in none of these do we find the depressed body,

the fixed gills, or the spiraculated aperture of the *Aspredinæ:* and all their other points of structure agree with the sub-families in which we have arranged them. Thus, *Cataphractus* has the perfectly mailed body and the two dorsals of the *Loricarinæ; Cyclopium* has the naked compressed body, and the adipose fin of the *Pimelodinæ;* while in *Cetopsis* there are all the general characters of the anguilliform *Silurinæ,* except that it has the minute vertical eyes of *Aspredo:* hence it follows, that all these become representations only of the present group in their own circles; they have, in short, a strong resemblance of analogy to *Aspredo,* but without any absolute affinity, seeing that the preponderance of their general characters, in all other respects, places them elsewhere. The passage from the *Aspredinæ* to our next division, appears to be made by two singular-looking fish, which Gronovius erroneously places in the genus *Mystus:* one of these has the minute vertical eyes of *Astroblepus* and *Aspredo,* with the body and fins of *Pimelodus,* or *Sorubium;* while the other, in all external points, evidently belongs to the same type as Spix's *Heterobranchus;* for both these latter have the elongated head, and the unequally lobed caudal, rounded at the end of its divisions, which is such a general character among the *Sorubinæ,* although no fishes among the *Pimelodinæ,* that we know of, have the caudal fin so constructed; neither is the first dorsal ray, as in these, slender and unarmed. We may thus trace the passage from the *Aspredinæ,* and proceed to the next group.

(289.) The Sorubinæ constitute the last division of this very extensive and intricate family. Although possessing something of the general appearance of the *Pimelodinæ,* they are readily distinguished from them, and indeed from all the other silures, by an unusually long and large head, having the muzzle very broad, flattened, and prolonged over the under jaw; so that the mouth, by this formation, is situated beneath (*fig.* 92.). For the comparatively recent discovery of this highly interesting group, we are indebted to the re-

searches of Spix, and the masterly descriptions of Agassiz.* Considering the immense number of forms, crowded,



as this also is, in the old genus *Pimelodus*, it would be quite premature to judge of the contents of this subfamily merely from the few species that have as yet been placed in it. It is sufficient, however, for our present purpose, that these are too remarkable to be arranged under any other division of the family, more especially as they are the only silures having that large, long, flat muzzle, which characterises the cartilaginous order of fish, the fissirostral type of birds, the aquatic order of quadrupeds, and the saurian reptiles. It is by this form, also, that the great circle of the *Siluridæ* is closed; for, in the genus *Sturisoma*, we have the muzzle and elongated form of *Sorubium*, joined to the mailed body of the *Loricaninæ*.

(290.) Before concluding our survey of the *Siluridæ*, we shall here introduce a few remarks upon two singular types, which will enter among these fishes; but of whose precise situation we feel doubtful. These are *Eremophilus* Humb., and *Heterobranchus* Spix: both these are described in two separate works, valuable, indeed, as specimens of typography †, but of such enor-

* We find an incidental notice of this group of Spix's in the *Règne Animal*, under the wrong name of *Sorubim*, no doubt a misprint for Sorubium.

† There is not a more serious drawback to the studies of the great majority of naturalists, than the publication of those national works, as they are called, which are intended to commemorate the scientific expeditions fitted out at the expense of the European governments. From the idea (we think a mistaken one) that no expense should be spared to render these publications as magnificent as possible; they are published at such a price as absolutely to debar all but princely naturalists from deriving any real benefit from them. The *grand ouvrage sur l'Egypte*, and the folios of Humboldt, are well-known instances of this typographical luxury; not to mention others of our own country, published by subscription, at the cost of between two and three hundred pounds. These publications, indeed, are professedly intended to promote science, but we have long thought

mous expense, as to be beyond the reach of private purchase; nor are specimens of either of these fishes to be seen in the London museums. The annexed cut of *Eremophilus* (*fig.* 93.) will show how much more it resembles

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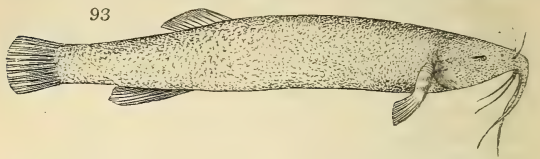

the *Siluridæ*, in general structure, than any other family; while the smallness of its eyes, and its single dorsal fin, gives it every appearance of belonging to the subfamily of *Aspredinæ*: that it will form a distinct type, cannot be questioned, although it has not even been mentioned by M. Cuvier. If the figure is correct, it would seem that the pectoral fins are placed on a peduncle, so as to form a joint at the base, in precisely the same manner as those of the frog-fish, or *Chironectidæ*; and hence we are led to infer that it is the representation of those fishes in the circle of the *Aspredinæ*, in which case it would stand as the most aberrant type, intermediate, perhaps, between *Cotylephorus* and *Mystus* of Gronovius. Of the genus *Heterobranchus* we have already spoken. Of the *H. bidorsalis*, our figure (87.), reduced from that in the great work upon Egypt, will give the reader a correct idea of its general form: but not having the means of consulting the

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that they produce a contrary effect. Five or six hundred pounds will but barely supply the working naturalist with such books as he must absolutely possess, if his researches are extensive, and he writes for the public: the additional purchase of such works of luxury as we here allude to, is, therefore, quite out of the question; and thus, they do not advance, but injure and impede science, by being so high priced as to debar nearly all naturalists from their possession. Fortunately, however, this extravagant taste is giving way to a more rational and useful mode of publication. The enterprising proprietors of The Naturalist's Library have set an example which we trust to see followed: they have, perhaps, erred in the other extreme; but this is, considering the pernicious effects of the folio system, a minor evil. All we now want is a series of *original* volumes of the same sort, to place the study of zoology, in all its branches, within reach of every one who desires to cultivate it.

original definition of this group by Geoffroy Saint-Hilaire, we shall here repeat what has been said on it by Cuvier. He observes: "It has the head furnished with a rough flat buckler, broader than in any other *Silurus*, because the frontals and parietals give out lateral plates, which cover the orbit and the temple: the operculum is still smaller than in the preceding genera (as *Doras*, *Ageniosus*, &c.); and what distinguishes these from all other fishes, is the peculiarity observed by M. Geoffroy, that, independently of the ordinary branchiæ, they have (an) apparatus ramified like trees, adhering to the superior branch of the third and fourth branchial arch, and which appear to be a sort of supernumerary gills: for the rest, their viscera resemble those of the other *Siluri*. Their branchial membrane has from eight or nine to thirteen or fourteen rays: their pectoral spine is strong and dentated; but nothing of this is to be found in the dorsal and anal: their body is naked and elongated, as are also the dorsal and anal fins; there is no spine to the dorsal: the caudal is distinct. Those which are known, have eight barbels: they come from the Nile, from Senegal, and from some rivers of Asia. Some, (forming the genus?) *Macropteromus* Lac. (or?) *Clarias* Gronov., have but a single dorsal, altogether radiated: others have a radiated and an adipose dorsal." The *Heterobranchus 5-tentaculatus* of Spix (*fig.* 94.) appears to belong to a different division of

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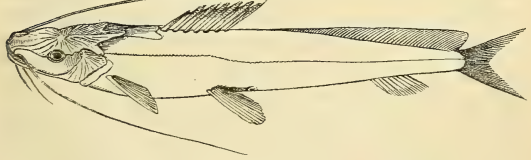

the family; and the annexed cut will show it has a much greater resemblance to the *Sorubinæ* than to the *Silurinæ*. In respect to the singular structure of the

ramified branchia, it is even a more extraordinary deviation from the usual form than that of *Syngnathus;* so that, if the latter genus deserves to be placed as a distinct division of the osseous fishes, according to Cuvier's system, *Heterobranchus* should form a third. We believe, however, that this variation in the branchia is not simply confined to one type only of the *Siluridæ,* but to several; at least, the fishes that are said by Cuvier, Geoffroy, and Spix to possess these ramified branchia, are widely different in nearly all other parts of their structure. It is, in short, by this means, that nature indicates the analogy which the aberrant *Siluridæ,* as a whole, bear to the amphibian sirens, which they represent; just in the same manner as the genus *Cinclus* among perching birds, by its aquatic or amphibious habits, represents the grallatorial order. To make this circumstance a reason for arranging *Cinclus* as a primary division of the perching birds, would appear to us as great a violation of nature as that of making *Syngnathus,* and all these *Heterobranchia,* types of distinct divisions in the osseous fishes.

(291.) The family of the COBITIDÆ, or loaches, have the greatest affinity to the last, near to which all ichthyologists have placed them. Like the silures, they are fluviatile fish, generally lurking close to the ground; and they probably feed in the same way, for the mouth is generally furnished with barbels, and the body is slimy. In all other respects, however, they materially differ, both from the *Siluridæ* and the *Cyprinæ,* or carps, in their structure, but more especially in their mode of propagation; for they are all viviparous, like the cartilaginous fishes, and thus stand alone among the malacopterygious families, as presenting almost a solitary exception * to the oviparous nature of all the others. The analysis we have given of the *Siluridæ* demonstrates that this remarkable group does

* Some of the *Siluridæ* are stated to be also viviparous; but we know too little of these fishes to sanction the belief that this mode of propagation is general among the great majority of the genera.

not belong to them; and although we are not prepared, at present, to adduce equally conclusive evidence that the loaches are excluded from the *Salmonidæ*, our investigations, as we have shown, have been carried sufficiently far to render such a supposition highly improbable. The viviparous nature of the *Cobitidæ* necessarily carries with it certain peculiarities in the generative organs, not necessary, indeed, to be here detailed; yet of great importance in determining the rank of this family in the circle of malacopterygious fishes.

(292.) The loaches, in comparison to the silures, are a very small group, whether we regard the number of species and forms already known, or the size of the fish themselves. They appear to be more numerous in the Indian rivers than in those of Europe, while those genera, which are found in the New World, are altogether peculiar. The common loach of Europe (*Cobites barbatula* Linn., *fig.* 95.), not unfrequent in England, is a

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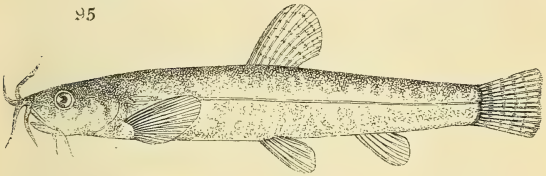

perfect example of the typical structure, and Dr. Hamilton has given us a few particulars of other genera, which are almost exclusively found in India. The common loach is generally met with in small running brooks, where, lurking under stones, it searches for worms and insects; and it swims rapidly when disturbed. It spawns early in the spring, and is very prolific: although it seldom exceeds four inches in length, its flesh is esteemed a great delicacy; so much so, indeed, as to have induced many wealthy persons on the Continent to transport them to their own waters. It is said that they owe their introduction into Sweden to Frederick I., who, at

much trouble and expense, had them brought from Germany for this very purpose. The pond loach, *Cob. fossilis*, is another European species, but has not yet been found in Britain; it is larger than the last, and sometimes grows to a foot in length. When the little pools it inhabits are frozen, or even dried up, it hides itself in the mud, where its tenacity of life enables it to live a long time: during stormy weather, like several other ground-feeding fish, it comes to the surface and agitates the water. In reference to this fact, Mr. Yarrell has well observed that "such fish as habitually reside near the bottom of waters, have a low standard of respiration, and a high degree of muscular irritability.* In such animals there is reason to believe there also exists great susceptibility of any change in the electrical relations of the medium in which they reside." This, indeed is proved by the restless movements of eels, loaches, and other ground fish, during storms of thunder, &c. which, as they effect a change in the electrical state of the atmosphere, extend, in all probability, the same influence, at least in a considerable degree, to the water. The pond loach, in fact, verifies this latter supposition, for, according to Ehrman, it is constantly swallowing air, which it discharges by the *anus*, after it has been changed, by passing through the body, into carbonic acid. Besides the peculiarity in the mode of propagation, as already remarked, which the loaches possess, there are other points in their anatomy which equally forbid us to class them in any other family. Mr. George Daniell has communicated to Mr. Yarrell the following peculiarities in the osteology of the common loach, which we shall here insert. "Attached to each outer side of the first and second vertebræ is a hollow sphere of bone of equal size, between which, on the upper surface, the vertebræ are distinctly seen; although the union of the two spheres underneath hides the vertebræ when looked towards from below. These circular bones, which are hollow, and the smooth insides of which can be seen

* British Fishes, vol. i. p. 22. 377.

through a horizontally elongated aperture that exists on the outer side of each,—these bones are analogous to the scapulæ: to their outer surfaces the bones of the proximal extremity of the pectoral fins are articulated; and the fin, being moved by powerful muscles, produces that rapidity of motion observable in this little fish." Another peculiarity, existing in the upper surface of the head, is the want of union in the two parietal bones at the top,—a deficiency which has been noticed by the late celebrated naturalist, Guilding, to occur in the *Iguana tubereulata*, or common guana of the West Indies. "This peculiarity in the loach," observes Mr. Yarrell, "is another instance of a relation in structure between the fishes and reptiles."* How far these peculiarities of the true loaches extend to the genus *Anableps*, and the other groups, is entirely unknown.

(293.) The natural arrangement of this family, from the paucity of forms yet known to belong to it, cannot, as yet, be attempted. We must therefore rest satisfied with taking a hasty glance at those few genera which, from their affinity to the typical *Cobitinæ*, or by being known to be viviparous, appear to form broken links in that chain of affinity which unites the loaches to the carps.

(294.) The extraordinary genus *Anableps*, or the double-eyed loach, is probably one of the typical examples. It was separated from the genus *Cobites* by Artedi †, and Gronovius has given three admirable figures of it in his valuable work.‡ Its body is cylindrical, covered by hard scales, and having the mouth furnished with numerous small teeth, while others, small and globular, are placed on the pharyngeal bones. It is chiefly remarkable, however, for its eyes, which are large, very prominent, and placed close to the snout; the frontal

* Brit. Fishes, vol. i. p. 380. We may also add, that this is likewise another evidence of the original union of the three aberrant circles of the *Vertebrata* into one great circle, as conjectured by us some years ago; so that the classes *Pisces*, *Reptilia*, and *Amphibia* would form a circle, were there not so many forms extinct among the saurian reptiles.

† Not, as Cuvier intimates, by Bloch.

‡ See Gronov. Zoophy. pl. 1. fig. 1—3.

bone forms a projecting ledge over them: the cornea and the iris are divided into two portions by transverse bands; so that, by having two pupils, the eyes appear to be double. Nevertheless, as Lacepede truly observes, there is but one chrystalline, one vitrea, and one retina—a structure, however, of which there is no other example among vertebrated animals. The organs of generation and the bladder of the male, as M. Cuvier remarks, "have their excretory canal in the anterior edge of the anal fin, which is thick, long, and clothed with scales; its extremity is pierced, and doubtless serves the purposes of coition." The female is not only viviparous, but produces the young in rather an "advanced stage of organisation." Only one species of this singular genus is yet known.

(295.) We have already given a general account of the loaches, all of which are left under one genus by Cuvier. We have, however, in consequence of the recent investigation of some Indian species, detected two principal groups and several minor variations, which constitute sub-generic distinctions, and have arranged the whole under a sub-family. The genus *Cobites* is distinguished by having no armature on the head; those with a broad, rounded tail-fin seem peculiar to Europe, while such as have this fin lobed or forked have hitherto been found only in India. The genus *Canthophrys*, as its name implies, has a hard spiny process, with one or more points, placed immediately beneath the eye, where, in a state of inaction, it reposes in a groove. Of these, which comprise three sub-genera, chiefly Indian, many are elegantly striped. Dr. Hamilton observes that they are more beautiful fishes than the ordinary loaches, which they but slightly resemble in their appearance, and differ from them still more in their habits, "especially in swimming higher, and in not remaining so stationary at the bottom." The fishes of this sub-genus are much compressed, and at first sight have a strong resemblance to some of the blennies; these two groups, in short, appear mutually to represent each other.

(296.) The sub-family *Pœcilinæ* contains a few freshwater fishes (*P. multilineata* Le Sueur, *fig.* 96.), of very small size, peculiar to America. In outward appearance they bear very little resemblance to the ordinary loaches,

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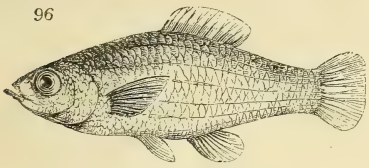

except, indeed, in the breadth and thickness of their tail. M. Cuvier, however, attests that they are also viviparous; and, as he places them close to the *Cobites*, we have been induced to do the same. These genera, obviously allied to each other more than to the typical loaches, have some few of the characters belonging to this family: their mouth is very small; the lips are fleshy; and the eyes close to the snout, which is small and horizontally flattened: on the other hand, they have no cirri — a circumstance which shows they are not ground-feeders. Their body is broad, oval, and often very high in the middle; and the dorsal fin, in the typical genus *Molinisea* (*M. latipinna* Le Sueur, *fig.* 97.), is so remarkably developed, that we consider this

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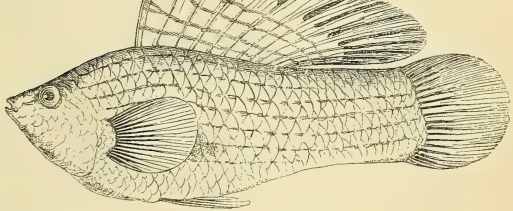

genus as a representation of the riband-fish, more especially as their eyes and gill-covers are very large.

With these two genera, we follow Cuvier in placing another, which he has named *Lebia* (*L. elipsoides, fig.* 98.), which differs in nothing from *Pœcilia* but in having

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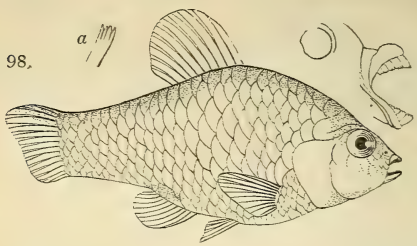

the teeth (*a*) serrated — a very questionable ground for generic difference when unsupported by any other character. We esteem ourselves fortunate in being able to present our readers with correct figures of these rare and interesting fishes, all represented of their natural size, from the masterly delineations of Le Sueur.

(297.) Hitherto, however, notwithstanding the analogy of these viviparous genera (and more especially of *Anableps*) to the cartilaginous order, we have mentioned no fish which *externally* possessed any resemblance to the latter, or gave us any idea that the *Cobitidæ* really exhibited any such modification of form as a flat head, large pectorals, and a transverse mouth, placed beneath a projecting snout, — characters, in fact, which every one knows are prevalent through all the cartilaginous types, and, therefore, peculiarly characteristic of them. There are, however, among the Indian drawings published by Hardwick and Gray, the figures of two species of their genus *Balitora*, which completely realises these particulars. No descriptions to these plates having yet been published, and not being aware that this genus has ever been defined by Mr. Gray, we can only be guided by the figures; but these leave us in little doubt as to the natural station of these singular fishes among the malacopterygious families. A glance at the figures here given of *Balitora Bricei*

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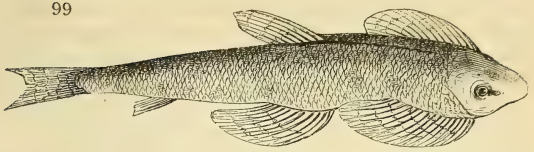

(*figs.* 99, 100.) will be sufficient to show that no fish yet discovered of the soft-rayed order makes so near an approach to the external shape of a cartilaginous fish as this; while the circumstance of its living in mountain streams *, joined to its single dorsal fin, small scales, and general habit, sanctions the idea that it enters within the confines of the family of *Cobitidæ*, of which it forms the platyrostral or cartilaginous type. Its analogy to *Calyonymus* and *Liparis* is likewise too obvious to require explanation; but, from both these, we consider it is far removed, were it only from the single circumstance of possessing small, but well-defined, scales. That there may be other links, yet discovered, between the malacopterygious and cartilaginous orders, seems to us highly probable. Our simple proposition in short is this, that, of all fishes yet known belonging to the former of these orders, those of the genus *Balitora* make the nearest approach, in their *external* structure, to the latter order: we therefore place it as the last of the *Cobitidæ:* and, as all authors agree in the affinity of *Polyodon* to the sharks, so do we arrange that genus as the first on the list of the aberrant cartilaginous genera, after quitting the *Malacopteryges* or soft-rayed order.

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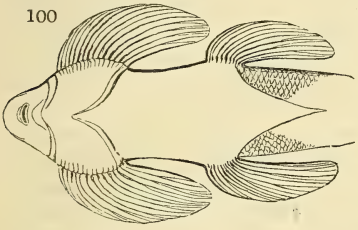

(298.) We shall now terminate our survey of the

* I imply this from the expression "*mountain streams*" upon the plate.

soft-rayed order, and our first volume, by a few general remarks on the *Siluridæ*. For many years previous to that analysis of the *Malacopteryges*, which we have laid before the ichthyologist in the foregoing pages, we had entertained a strong idea that the *Siluridæ* connected this great division of osseous fishes with the cartilaginous order, on account of the general depression and breadth of their head, the inferior situation of the mouth in several genera, and the viviparous nature of others. But, upon analysing this family, in conjunction with that of the *Gadidæ*, we were induced to relinquish this idea. Affinity of general structure must always be the primary object of the naturalist's researches: if this is studiously followed up, and successfully traced, the analogies he is desirous of possessing, to strengthen his views of affinity, are sure to follow; because they exist throughout all nature, material or immaterial. The close connection of the *Gadidæ* with the *Gymnetres*, or riband-fish, by means of *Cepola* in one, and *Brotula* in the other, proves at once the situation of these two families to be annectant between the two great divisions of osseous fishes. Now, it is clear that the *Siluridæ* show an affinity to the *Gadidæ* sufficiently strong to authorise our placing them in succession; and it is equally clear that the *Cobitidæ* intervene between these and the salmon family. On these considerations, therefore, we arranged our groups, and on these affinities do we take our stand; not, indeed, presumptuously, but with the most ardent desire of acquiring further knowledge, and a vivid impression of the great things which will hereafter be done in this little-known department of zoology, when we shall have long passed away to purer and brighter regions, removed alike from the censure of opponents or the applause of friends.

END OF THE FIRST VOLUME.

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